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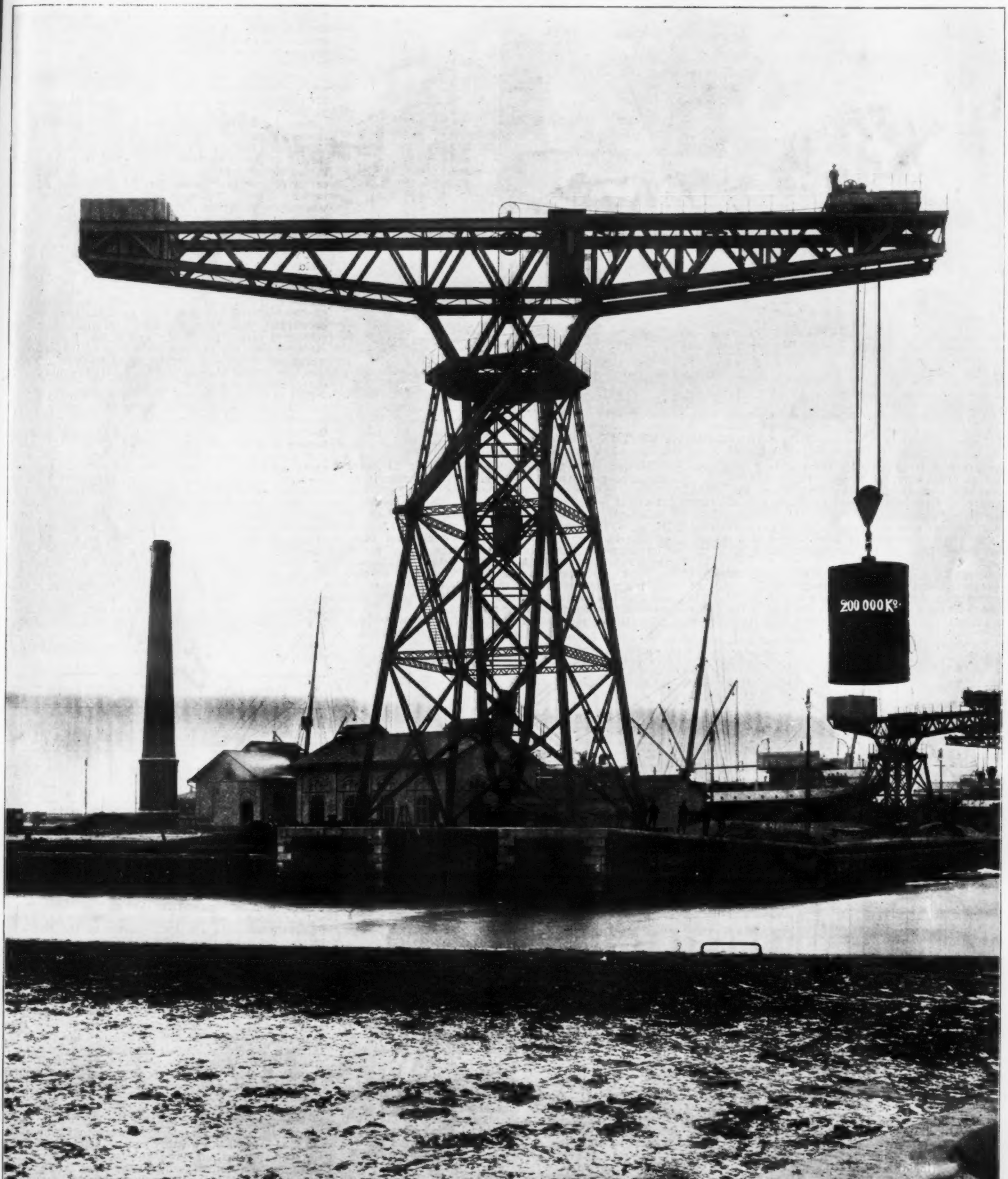


THE GIANT CRANE AT BREMERHAVEN, WITH ITS TEST LOAD OF 200 LONG TONS.

THE GIANT CRANE OF BREMERHAVEN.

The rapid development of the German shipbuilding industry, and the tendency to build larger and more powerful steamers than have hitherto been built, has necessitated a corresponding improvement in the equipment of German dockyards, and more especially in their machinery for handling large and heavy weights. The Benrather Maschinenfabrik Actien-Gesellschaft built the crane shown in the illustration on the front page, for the Kaiser dock at Bremerhaven. This has been described as the largest crane in the world, and in the illustration reproduced from a photograph it is shown with the test load of 200,000 kilos, or about 197 tons, hanging on.

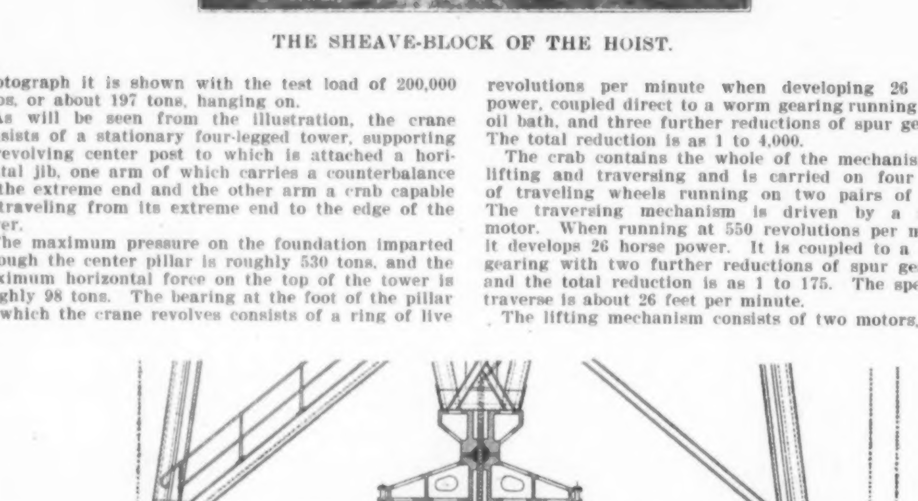
THE SHEAVE-BLOCK OF THE HOIST.

As will be seen from the illustration, the crane consists of a stationary four-legged tower, supporting a revolving center post to which is attached a horizontal jib, one arm of which carries a counterbalance at the extreme end and the other arm a crab capable of traveling from its extreme end to the edge of the tower.

The maximum pressure on the foundation imparted through the center pillar is roughly 530 tons, and the maximum horizontal force on the top of the tower is roughly 98 tons. The bearing at the foot of the pillar on which the crane revolves consists of a ring of live rollers running between two cast steel roller paths. The diameter of the bearing to the center of the rollers is 7 feet 3 inches. There are 35 hardened conical steel rollers about 7 inches in diameter at the center, and 10 inches long, and they run in an oil bath to minimize friction. The main driving wheel, which forms at the same time the upper roller path, has a pitch line diameter of 13 feet 1½ inches. Like the top roller path of the foot bearing, the foot of the center pillar itself consists of a steel casting, and the pressure is imparted to the foot bearing through a cylindrical pin lying horizontally between the foot of the center pillar and the top roller path of the foot bearing, both surfaces being slotted, so that the pin is almost half embedded in both. In this way a hinge is formed, and this is necessary in order that as the pillar bends slightly, in consequence of the horizontal forces it has to withstand, the pressure on the foot bearing remains exactly central and equally distributed among all the rollers. The upper bearing at the top of the tower consists of a double wrought steel ring and four pairs of rollers about 3 feet 3 inches in diameter, running in bearings fixed to the center pillar.

The slewing mechanism consists of an inclosed series-wound tramway type motor, running at 550 revolutions per minute when developing 26 horse power, coupled direct to a worm gearing running in an oil bath, and three further reductions of spur gearing. The total reduction is as 1 to 4,000.

The crab contains the whole of the mechanism for lifting and traversing and is carried on four pairs of traveling wheels running on two pairs of rails. The traversing mechanism is driven by a series motor. When running at 550 revolutions per minute it develops 26 horse power. It is coupled to a worm gearing with two further reductions of spur gearing, and the total reduction is as 1 to 175. The speed of traverse is about 26 feet per minute.



THE SUBSTRUCTURE OF THE GREAT CRANE.

The lifting mechanism consists of two motors, each developing 17½ brake horse power at 450 revolutions per minute, coupled to four reductions of spur gearing and two barrels, each about 4 feet in diameter, winding jointly one part of an eight part rope. The two motors are connected in parallel, and their armature spindles are coupled together with a pinion between them so that they practically form one motor. There are four changes of gear on the second motion shaft, and the rate of lifting varies from 2 feet 7 inches per minute with 150 tons to 23 feet 3 inches per minute with 18 tons. Two warping barrels with parallel grooves are used for hoisting, the end of the rope being kept taut and stowed away by attaching it in twelve parts to a rising and falling weight inside the center pillar.

The general dimensions of the crane are as follows: Total length of jib, 164 feet; maximum radius to center of load, 72 feet 2 inches; height of gantry rails from the ground, 114 feet 10 inches. The total weight of the crane, including the counterbalance, is 474½ tons.

The same firm has now built six large cranes of this type for shipyards, for maximum working loads varying from 50 tons to 150 tons; the latest and largest of all, that for the Howaldtswerke at Kiel, is constructed to lift a working load of 150 tons and a test load of 200 tons at a maximum radius of 65½ feet, 50 tons working load at a maximum radius of 134½ feet, 15 tons at 138½ feet, and 154½ feet height of gantry rails above ground.

THE PURIFICATION OF FEED WATER.

In the "memorandum" prepared by Mr. C. E. Stromeyer, the chief engineer of the Manchester Steam Users' Association, and presented to the members of the association at their last annual meeting, there is included an exceedingly interesting report dealing with the results of an examination into the results obtained in practical working with various types of purifiers for feed water. By the kind permission of Mr. Stromeyer we reproduce this report below, together with his remarks on the cleaning of boilers worked without purifiers.

Scale and Corrosion.—As mentioned in my last year's memorandum, we have now established a chemical laboratory, and have during the last twelve months carried out many analyses on feed waters, and are now in possession of full information as to the mineral and corrosive constituents of most of the water supplies to large towns. Those of our members using these waters are receiving revised instructions as to treatment. Many members whose works are situated in other districts have also had their waters analyzed and reported upon by us.

A very general request is for information as to how scale can be got rid of entirely, and how the expense of scaling can be obviated, to which there is, of course, only one reply, viz., that the water should be treated before it is fed into the boiler, and, not unnaturally, further inquiries are then made as to the relative costs of working feed-water purifiers. Information on the subject is rather conflicting, and it was therefore decided to send our chemist on a tour of inspection of works where various purifiers could be seen in operation, and a brief summary of his report is contained in the following pages:

Cost of Working Boilers Without Purifiers.—In order fully to understand the nature of the inquiry, it has been thought desirable to make a rough estimate as to the annual cost of installations with from one to seven boilers of 8 feet diameter, costing £800 with setting, and using in one case pure water, and in the other cases sedimentary water. The interest on the first outlay is taken at 3 per cent, and the interest on the sums set aside for depreciation is also taken to be 3 per cent. On account of the assumed rapid wear of the hard-worked boilers, their lives are supposed to be relatively short. The best worked boiler without scale is supposed to last 50 years, requiring no scaling. The worst cases would be a boiler worked say for stretches of three months because there is no spare boiler, and this is supposed to last only 15 years. Even in six weeks the scale is supposed to have grown thicker than is desirable. This would reduce the life of six and one spare boiler to 20 years. In the next best lot, having one spare boiler for every five, each gets cleaned every five weeks, lasting, say, 30 years; while all the others are scaled every four weeks, lasting, say, 40 years.

Nature of Feed.	Pure.	Very Sedimentary Water.						
Boilers at work	1	1	1	2	3	4	5	6
Spare boilers	0	0	1	1	1	1	1	1
Assumed life of boilers	50	15	40	40	40	40	30	20
	£	£	£	£	£	£	£	£
Interest on first cost	24	24	48	72	96	120	144	168
Depreciation	7	43	21	32	42	52	100	209
Scaling and cleaning at 30s	2	6	31	47	62	78	78	78
Chemicals	2	10	10	20	30	40	50	60
Totals.	35	83	110	161	230	290	372	515
Totals per working boiler	35	83*	110	80.5	76.7	72.5	74.4	85.8

*NOTE.—The actual cost would be much greater, as the works would be closed down for four weeks per annum.

The probable ages which the boilers may attain are based on the assumption that the gradual accumulation of scale during the time that each of these boilers will be allowed to run will increase the wear and tear, and will have the effect of shortening the life of a boiler, and also that those installations where the boilers get little rest will not be scaled so well as others. The cost of scaling includes the operation of laying off the boiler.

It will be seen that the annual cost (chiefly interest) for a boiler using pure water, with only such chemicals as prevent corrosion, would be about £35, whereas boilers using sedimentary waters would cost from £37 to £75 more. If, then, it can be shown that the interest, depreciation, and working expenses of a water-softening apparatus per boiler amount to less than these extra expenses, its advantage in connection with very sedimentary water is demonstrated.

A charge of 30s. for cleaning boilers is fairly high, but even in works where it is less, the extra cost of boilers using sedimentary water is not much reduced. The table will be useful as showing that where the question arises as to whether a spare boiler or a water-softener is to be put down, the latter would seem to be the more advantageous, and the information which our chemist (Mr. Baron) collected will throw more light on the subject.

SUMMARY OF REPORT ON FIFTEEN WATER-SOFTENERS.

Except where the installations were practically new,

or where they were under the eye of a chemist, the manufacturers' instructions were rarely adhered to. In one case the quantity of added lime had been doubled, making the water harder than it was before treatment; in another case the settling tanks had never been emptied, with the result that the sediment had filled the tanks, and was as hard as a rock. These experiences are to be regretted, because the water-softeners are designed so as to be worked by the fireman, who, if he receives proper instructions, is quite capable of carrying out the necessary manipulations.

The principle of water-softening is a simple one. To remove the temporary hardness, caused by dissolved carbonate of lime and magnesia, a certain quantity of burnt lime has to be added to the water, when precipitation should occur. To remove permanent hardness, carbonate of soda should be added, and further precipitation should occur. In practice it is found that this precipitation is slow, so that the settling tanks have to be made large, or filters have to be used, which are, of course, inconveniences, and the various patentees have tried to overcome them, as follows:

1. The treated waters are mixed with old sediment.
2. They are mechanically stirred.
3. They are stirred by air jets.
4. They are heated.
5. After having settled, the nearly clear fluid is treated with carbonic acid, which dissolves the sediment.

The treatments under 1 and 2 are fairly satisfactory, and, particularly if filters are also used, lead to a very important reduction in the height and size of the settling towers. These are generally fitted with baffle-plates, etc., though by increasing the velocity and changing the courses they cannot be looked upon as tending to expedite clarification of the water.

The treatment under 3 is effective as regards clearing the feed, but as the water thereby gets impregnated with air, the water is made more corrosive than it would otherwise be.

If, as in 4, the water is heated, the chemical reaction is rapidly completed, and the scale deposited. If the heating takes place in an economizer, the tubes rapidly get choked with soft scale, and have to be cleaned frequently, but little or no scale gets into the boiler. If the water is passed through tubular heaters, these take the deposit, and, unless special provisions are made, its removal is troublesome. To heat newly-purified water by live steam from the engine is an objectionable practice, for the cylinder grease combines with the final precipitate, and forms a light, pasty substance, which adheres to the heating surfaces and causes bulges, or collapses. If, as in the case of the Stanhope and the Wollaston purifier, the feed is heated by live steam before treatment, the cylinder grease and all the sediment appear to get removed. There must, however, be a considerable loss of heat by radiation, which makes it appear desirable to cover the tanks, or otherwise keep them warm.

The treatment 5 is open to the same objection as that of 3.

Some water-softeners work continuously; others are so arranged that a tankful is prepared at a time. Then, of course, the measuring of the chemicals is a simple matter; whereas if the process is continuous, the devices for obtaining a steady supply of chemicals are numerous and ingenious. The lime is either in the form of milk of lime or lime water, the latter being very bulky. In some softeners the flow depends on the size of nozzles, in others on the difference of density, and in others, again, small measured quantities are tipped into the feed by mechanical means. Probably the old arrangement of using adjustable pumps is the cheapest and most reliable.

Porter-Clark Continuous Water-Softener.—This is the oldest and best known for treating only temporary water. No definite information could be obtained as to the quantity of lime, except that 1 cwt. was used at a time. The milk of lime is pumped into the water-supply pipe, and the mixture is delivered into (b) two mixing cylinders 4 feet in diameter, which are also agitated by engine power so as to insure thorough mixing. From these cylinders the water passes

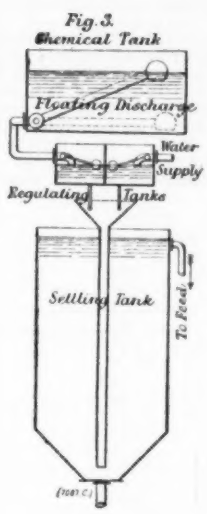


FIG. 3.—THE TYACKE CONTINUOUS WATER-SOFTENER.

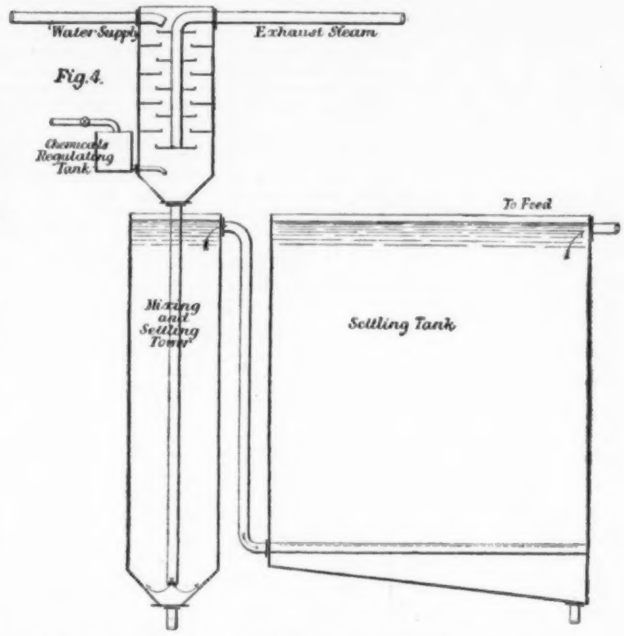


FIG. 4.—THE WOLLASTON CONTINUOUS WATER-SOFTENER AND HEATER.

through (c) four 2 foot filters, whose preparation entails much labor, and then into two tanks (d), each occupying a floor space of 36 feet by 20 feet. In the second of these tanks caustic soda is added, which converts the clear water into a turbid one. The object of this last proceeding was not very clear, and may have been necessary for trade purposes; but if it was intended to remove any permanent hardness, it would have been better and cheaper to add soda ash, not caustic soda, to the milk of lime. The cost of this installation was £400, without the two large tanks which constitute the roof. The total floor space covered is 1,526 square feet. Herewith are given the analyses of two samples before and after treatment; but they must have been taken on different days, for the process could not diminish the amount of sulphuric acid and hydrochloric acid, which, as will be seen, are much diluted.

Composition of Water	Before Softening	After Softening	Change
	Grains	Grains	Grains
Calcium carbonate	11.512	1.034	10.478 loss
" silicate	0.836	2.407	1.571 gain
" sulphate	1.556	2.124	0.568 "
Magnesium carbonate	5.876	4.831	1.045 loss
Ferric oxide, etc	0.472	.199	0.273 "
Scale-forming minerals	20.252	10.595	9.657 loss
Sodium chloride	5.703	5.562	0.141 loss
" sulphate	10.500	8.440	2.060 "
Total soluble salts	16.203	14.002	2.201 loss
Total mineral matter	36.455	24.597	11.858 loss
Carbonic acid gas	6.94	5.98	0.96 loss
Oxygen gas	0.66	0.66	0.0 "

Treatment required for 1,000 gallons: Pure lime, 1.5 lb.; pure soda ash, 0.2 lb. The actual treatment could not be determined.

As will be seen, in spite of the addition of lime, the free carbonic acid has not been much reduced: this is doubtless due to the large open tanks, the water being thus in contact with the air, and absorbing almost as much carbonic acid as was taken out in the process.

B. In this installation there were no filters. Lime and soda for 24 hours' treatment were mixed in a cylinder 4 feet in diameter, 15 feet high, and kept agitated by paddles, driven by an engine which also worked the pump which delivered the above mixture into the water supply. This water entered the mixing tower at the top, and was drawn off at the bottom, and delivered into the bottom of a settling tower, 13 feet in diameter, 22 feet high. It then overflowed into a feed-well. No information as to cost or quantity treated was obtained, and nobody seemed to take an interest in the working. The boilers were said to have more scale than when no softener was used, which is quite possible if too much lime were added.

C. This installation is capable of treating 13,000 gallons per hour, and includes filtration, which, of course, involves a fair amount of labor. The tank for preparing the milk of lime is 5 feet 10 inches by 5 feet 4 inches and 6 feet high. It is provided with engine-driven paddles and a pump. The water and milk of lime pass into the top of the mixing tower, 5 feet in diameter and 23 feet high, and from the bottom they pass into the bottom of another tower of the same size, and overflow to four filters, 2 feet square. About 2 hundredweights of lime are added per 80,000 gallons.

The Stanhope Continuous Water-Softener is illustrated in Fig. 1, for which the block has been kindly lent by the company. Two installations (D and E) were visited, but one was not at work, and the other had been adapted for special purposes.

D is capable of treating 3,000 gallons per hour, and covers a floor space of 13 feet by 11 feet 6 inches. The water supply enters a distributing tank, the inflow

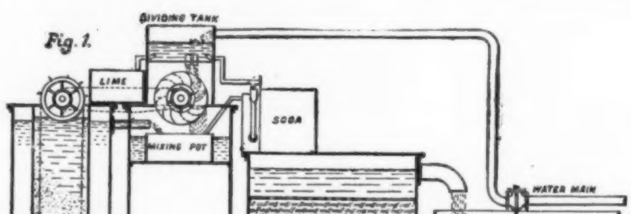


FIG. 1.—THE STANHOPE CONTINUOUS WATER-SOFTENER.

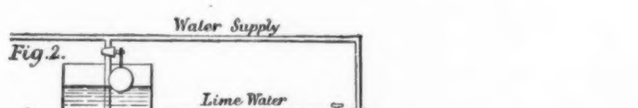


FIG. 2.—THE ATKINS CONTINUOUS WATER-SOFTENER.

hardness. Three installations (A, B, and C) were visited.

A. This installation is capable of dealing with about 3,000 gallons per day, but is only used for 2,000. It consists of (a) a lime-mixer, in which two paddles are worked by an engine, constantly stirring up milk of lime, which is prepared by adding burnt lime to

being regulated by a ball valve actuated by the height of the water in the feed tank. The distributing tank has three outlets, whose areas are all carefully adjusted, so that relatively the right proportions shall flow into the lime tower, into the soda tank, and into the mixing pot, the overflow from the lime tower and the soda tank adjoining. Lime is placed in the tower, and is agitated, but in such a manner that the top of this tank is undisturbed, and only clear lime water, not milk of lime, overflows into the mixing pot. The amount of soda also depends on the amount of water flowing into the tank. From the mixing pot the mixed water passes into the first settling tank, where most of the sediment is deposited, and it then passes into a tower fitted with baffles and a filter, from which it overflows into the feed tank.

E. The other installation was similar but larger, and need not be described.

The Stanhope Company have also combined feed softener and heater, but no installation was visited. The combined action of chemicals and heat ought to be very efficient.

The Atkins Continuous Water-Softener is illustrated in Fig. 2. It only removes temporary hardness. Two installations (F and G) were visited, but in neither case were the patent filters in use, their tanks being filled with wood shavings.

Composition of Water	Before Treatment	After Treatment	Change
	Grains	Grains	Grains
Calcium carbonate	13.863	38.920	25.057 gain
" oxide (lime)	0.0	14.300	14.300 "
" silicate	2.062	3.591	1.529 "
" sulphate	1.625	2.121	0.496 "
Magnesia	0.0	0.266	0.266 "
Ferric oxide, etc.	0.447	0.987	0.540 "
Scale-forming minerals	17.997	60.185	42.188 gain
Calcium chloride	1.331	2.114	0.783 gain
Magnesium chloride	0.672	0.0	0.672 loss
Sodium chloride	0.479	0.476	0.003 "
Soluble salts	2.482	2.590	0.108 gain
Total mineral matter	20.479	62.776	42.297 gain
Carbonic acid gas	9.71	0.0	9.71 loss
Oxygen gas	0.06	0.06	0.0

Treatment required: 1.8 lb. lime, 0.2 lb. soda ash per 1,000 gallons. Apparently 5½ lb. of lime were added, and no soda

It would appear that the baffles in the settling tank effectively prevent a settlement, and also, that in case of the water supply being checked, the lime water would still flow on at its original rate, and the result would be very irregular and unsatisfactory.

F. This installation treats 500 gallons per hour. The lime tower is 2 feet in diameter and 6 feet high. The clear lime water, as well as the supply, flow into the mixer, and thence into the settling tank, which is 7 feet long, 3 feet wide, and 5 feet high, and then into the filter tank, which measures 2 feet 3 inches by 3 feet 3 inches, and 4 feet high. The floor space covered is 35 square feet. It was stated that the hardness was reduced from 15 to 7 grains per gallon. Ten pounds of lime are used for 60,000 gallons per week.

G. This installation was slightly larger than the above, and is said to have cost £115.

It was found choked with lime deposits, but was apparently got into working order after the inspection, and two samples were submitted for analysis (see above). As will be seen, the hardness was not decreased, but increased from about 18 to 60 per cent, this being doubtless due to the ball tap on the lime tower being too full open, or the tap on the settling tank too much closed, or perhaps the lime water was not clear.

The Tyacke Continuous Water Softener is illustrated in Fig. 3. Only one installation (H), and that a small one, was visited. It occupied a floor space of 3 feet 8 inches in diameter, and treats about 200 gallons per hour, but only for temporary hardness.

H. There are two chemical tanks, 2 feet by 4 feet by 2 feet, which are alternately filled with water and a little lime. This lime water is clear. A connection is opened which allows a floating discharge pipe to deliver this water into the regulating tank, in which the water level is kept constant by a ball valve, and the outflow through a carefully-gaged nozzle is also constant. The water supply enters the adjoining regulating tank, and also flows out through a gaged nozzle. These waters are then carried to the bottom of the settling tank, 3 feet 6 inches in diameter, 6 feet high, and pass upward and through a bed of shavings, overflowing to the feed tank. This apparatus could be used for treating permanent hardness by adding soda to the lime water.

The fireman attended to the apparatus, which worked all right, reducing the hardness down to 6 grains per gallon.

Wollaston's Continuous Water-Softener and Feed-Heater Combined (see Fig. 4).—I. One installation was visited. The water supply and exhaust steam enter a vessel fitted with trays, and into the bottom of this a small stream of chemicals is pumped from a regulating tank and to the bottom of the mixing and settling tower, 3 feet in diameter. Here the grease from the steam and the sediment from the water accumulate, the thoroughness of the settlement being doubtless due to the heat and to the fact that the new sediment comes in contact with the old. The overflow is led to the bottom of a larger settling tank, 10 feet by 5 feet, and 12 feet 6 inches high, from the top of which the feed water is drawn off. This settling tank contains baffles, which are believed to accelerate the precipitation, but heat is doubtless the more important factor, and it would appear advisable to reduce the radiating surfaces of the tanks and to keep them warm.

Brunn-Lowener Continuous Water-Softener (see Fig. 5).—One installation (J) was visited; although no samples were obtained, it seemed to be working satisfactorily.

J. The lime and soda ash, in proper proportions, together with a certain quantity of water, are placed in the chemical tank. It is of semi-cylindrical shape, and has a blade which every now and then stirs up the milky mixture. The water supply is run into a measuring tip, consisting of two triangular troughs; when one is full, it tips over and allows the other to fill; while tipping, it moves the stirrer and also momentarily opens a little valve in the bottom of this tank, which allows a definite quantity of chemical to be discharged. This and the water from the tip falls into the mixer, and from there they flow into the settling tower, the sediment remaining at the bottom, and the nearly clear water passes through the filter to the feed tank. The arrangement would be an ideal one if the quantity of chemicals discharged through the valve each time the tip moves could be made independent of the depth of the milky fluid. A spoon for measuring out the chemicals, either fluid or dry, would seem to be more suitable.

Desrumaux Continuous Water-Softener (see Fig. 6). —Two installations (K and L) were visited. Their main feature is that the motive power to be got out of the water supply is employed to turn a small water wheel which agitates the water in the lime tower, and in the newer forms it also serves to measure out the desired quantities of soda solution.

K. The water enters a small regulating tank with two nozzles, one discharging through a hollow shaft to the bottom of the lime tower, which is 39 inches in diameter and 12 feet high, and the other discharging over the water wheel into the mixing tank, which also receives a steady stream of soda solution from a tank. The water passes from the mixer to the bottom of the settling tower and filter, which is 8 feet 3 inches in diameter and 22 feet high. This installation treated nearly 3,000 gallons per hour, and reduced the hardness from 38 grains to about 2 grains, but no samples were taken.

L. This installation had only just been erected, and was not working. The lime tower is 8 feet 4 inches in diameter, and the settling tower and filter is 18 feet 6 inches in diameter and about 46 feet high. This apparatus is intended to treat 60,000 gallons per hour.

The Reisert Continuous Water-Softener and Feed-Heater was not seen at work, but as it contains several novel features it is here mentioned. In one apparatus the temporary hardness is removed by intense boiling, and the permanent hardness is removed by the addition of carbonate of soda. The apparatus shown in Fig. 7 treats the water by the cold process. The water supply enters the distribution tank, which has three accurately-bored nozzles. One discharges into the soda tower, the other into the lime tower, and the third into the bottom of the settling tank and filter. Every day the soda tower is emptied and refilled with strong soda ash solution of a given density; while working water runs into the top of this tower, and causes the dense soda solution to overflow into a funnel and through a pipe to the bottom of the settling tank, where it mixes with the water supply. Into the tower a given quantity of burnt lime is every day introduced, and a regulated supply of water, entering at the bottom, makes saturated lime water; the clear overflowing lime water also enters at the bottom of the settling tank. Here both chemical solutions mix with the remainder of the water supply, and the precipitate formed lodges in the bottom. The partially-clarified water passes to the top of this tank, which, as will be seen, has a filter across its middle, and the water then flows away to the feed tank. By an ingenious arrangement the current through the filter is momentarily reversed when the sediment in the filter has grown too thick and requires washing out.

The Archbutt-Deeley Water-Softener (see Fig. 8), unlike any of the previous ones, works intermittently, and therefore two settling tanks are necessary, unless the softening is done overnight, or unless the water when purified is run into a storage tank.

Four installations (M, N, O, P) were visited.

M. This installation treated about 2,500 gallons at a time, or about 1,000 gallons per hour. There is a

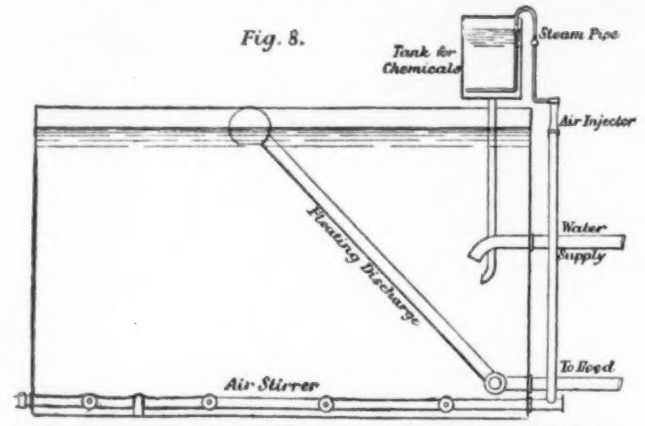


FIG. 8.—THE ARCHBUTT-DEELEY WATER-SOFTENER.

FIG. 5.—THE BRUNN-LOWENER CONTINUOUS WATER-SOFTENER.

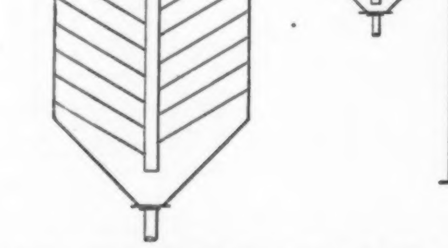


FIG. 6.—THE DESRUMAUX CONTINUOUS WATER-SOFTENER.

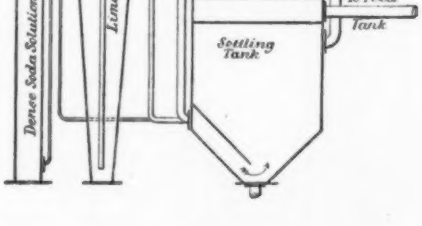


FIG 7.—THE REISERT CONTINUOUS WATER-SOFTENER.

small tank into which weighed quantities of lime and soda ash are placed, to which water is added, and steam is then turned on till these chemicals are boiling. The water supply is turned on to the large mixing and settling tank, 8 feet cubed, and when full the chemicals are run in. Steam is now turned into the air injector, which drives air through the air-stirrer pipes in the bottom of the settling tanks, whereby a thorough mixing of the water, chemicals, and old sediment is effected. The new sediment adheres to the old, and during the following period of rest is quickly precipitated. When the upper layers of the water are clear, they are drawn off by means of the floating discharge. This stands in connection with a coke stove, and in passing out the water absorbs some carbonic acid, which, combining with the, as yet, unprecipitated lime in the water, makes it permanently clear. The water is now run into a storage tank of 5,500 gallons capacity, and is from there drawn off by the feed pump. The cost of this installation was stated to be from £150 to £200. About 16 tanks are softened per week; of these only eight are carbonated by contact with the stove gases.

The above treatment seems to be a correct one. The discrepancies between treatments required and adopted being due to impurities in the lime, and the addition of alumina ferric, which requires more soda and lime.

N. This installation can treat about 8,000 gallons at a time, or about 3,000 gallons per hour. The mixing and settling tank measures 12 feet 3 inches square by 10 feet deep. The pure water is run into a large storage tank. The boiling and agitation in the large tank takes 10 minutes, the settling about one hour, and the running-out about another hour. At these works the carbonater is used only once a week, in the belief that this will keep the pipes free from scale. The reagents used are 6 pounds lime and 1¼ pounds soda ash per tank of 8,000 gallons. The water is usually tested once a week, or when there is a change of weather. The cost of this apparatus was £296.

O. The mixing and settling tank of this installation

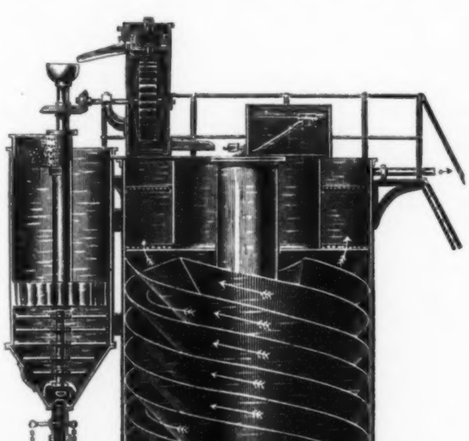


FIG. 9.—THE DESRUMAUX PURIFIER.

measures 10 feet square by 8 feet deep. It costs £150, and treats about 3,000 gallons per hour. Only lime is used as a chemical, and the hardness is reduced from 32 to 16 grains. The attendant's labor amounted to about four hours per day. The clear water was not brought in contact with carbonic acid.

P. This installation is nine years old, and treats 24,000 gallons at a time, the tank measuring 24 feet square and 10 feet deep. The water is not carbonated. Its hardness is reduced from 13.3 to 7.1 grains.

The opinion of Mr. Baron, our chemist, is that the Archbutt-Deeley apparatus, and several of the more refined continuous water-softeners, particularly if the treated waters are heated, should give excellent results, provided correct instructions are given as regards quantities of lime and soda to be added, and provided also that rough chemical tests are occasionally made to ascertain the hardness of the water before and after treatment. The idea of having to make such tests may deter some from adopting water-softeners, but, as will be seen by the following brief description, the simple tests for hardness can be carried out by anybody.

CHEMICAL TESTS.

Soap Test for Total Hardness.

A standard solution of soap (which can be bought) is prepared by dissolving soap in water and checking it against water of standard hardness.

A small quantity of water to be tested is measured and poured into a glass-stoppered bottle; a small quantity of standard soap solution is added and the mixture then shaken. At first the water contains too much hardness to form a lather; but as more and more soap is added it gets softer, and lather is formed which does not disappear on standing. The quantity of standard soap solution added is the measure of the—

I. Total hardness of the water.

II. The permanent hardness is determined cold by the soap test after first boiling the water for a long time so as to remove all temporary hardness. The difference of I. and II. is the temporary hardness, but this test is not very accurate. It is better to test for—

III. Temporary hardness as follows: A standard acid solution (which can be bought) is prepared by mixing a given quantity of pure acid with water. A small quantity of water to be tested is measured into a white bowl, and one drop of an aniline dye, called methyl orange, is added, and then small quantities of standard acid are poured in until the yellow color of the dye changes into a red one. The quantity of standard acid added is the measure of the temporary hardness, and the permanent hardness is the difference of I. and III.

Roughly speaking, the degrees of temporary hardness fix the amount of lime or caustic soda to be used, and the degrees of permanent hardness fix the amount of soda ash to be used.

From the preceding remarks on the fifteen water-softening installations visited, and from other information, it would appear that, roughly speaking, the cost of the plant per 1,000 gallons treated per hour would be from £100 to £150, and as 750 gallons per hour is about as much as one 8-foot Lancashire boiler can evaporate, it will be seen that it is cheaper to adopt a water-softener than to lay down a spare boiler, if only one boiler is in use; and even if there are six boilers, the advantage would still be with the softening plant on account of lesser cost of the chemicals which could then be used, and the saving in the cost of scaling.

Experiments on corrosion are now in progress, and it is hoped soon to obtain definite results on this very important subject. For our engravings and the foregoing particulars we are indebted to Engineering. In this connection another article on "Continuous Water-Softening" is of interest.

In the following article we propose describing two apparatus, devised for the purpose of softening water by a continuous process, which have been brought to our notice, says the Engineer. A number of installations for softening water by means such as these are at work, we are informed, satisfactorily at various places, both in this country and on the Continent. Before describing the actual machinery employed, a word or two as to the general principles involved may be of interest. Our readers will be aware of the usual method of softening and purifying water by the addition of lime water in conjunction, perhaps, with carbonate of soda. The hardness of water is caused principally by calcium and magnesium salts. The calcium salts are in the form of bicarbonate and sulphate of calcium. Bicarbonate of magnesium also appears. The bicarbonates are fairly soluble, but the simple carbonates are so little soluble that they may, for practical purposes, be described as

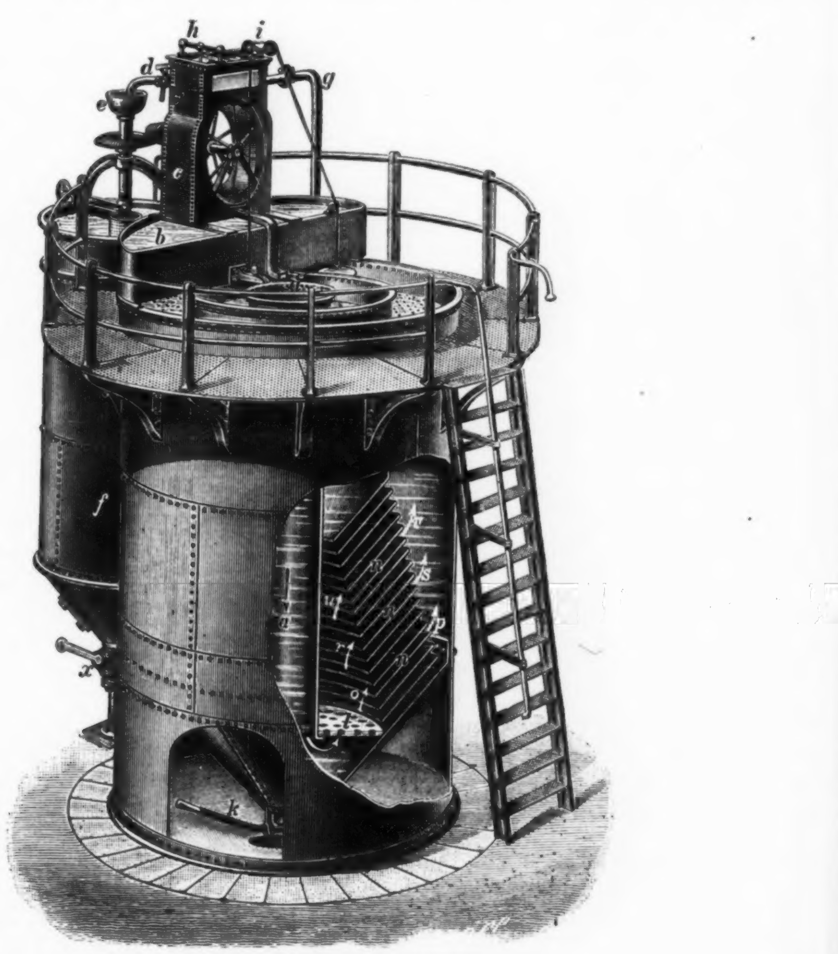


FIG. 10.—THE BEISSEL PURIFIER.

insoluble. The dissolved bicarbonates of calcium and magnesium may readily be expelled from the water by the addition of a solution of quicklime. This removes a portion of the carbonic acid from the bicarbonates, forming the simple carbonates, which appear in a very fine insoluble powder and render the water turbid. When this powder has subsided the water is clear, and to a considerable degree softened. The sulphate of lime is got rid of by the addition to the water of a solution of carbonate of soda, which causes a double decomposition, sulphate of soda and carbonate of calcium being formed, the latter being deposited in the same manner as that already described, while the former remains in solution. These processes have, of course, been well known and practised for a long time. They are employed most usually in this country in connection with settling tanks, the purified water being drawn off when the milkiness caused by the carbonate of calcium in suspension has subsided. A number of tanks are used, so that a supply of softened water may be more or less continuous—several tanks being in various stages of settlement while one is

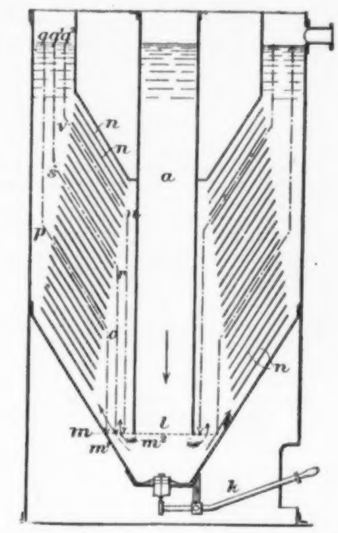


FIG. 11.—THE BEISSEL PURIFIER.

being drawn from—but this system can in no sense be called absolutely continuous, as the two which are now under consideration claim to be. When using tanks the time of settlement is protracted. Thus a particle will take, under ordinary circumstances, some six hours to travel downward through a depth of 3 feet. It is obvious that if this 3 feet be divided up into a number of different layers the clearing will take place proportionately more quickly.

This is exactly what has been done in the two systems which we are just about to describe. Take the first of these, for example. It is known as the "Desrumaux," and the London offices of the company which manufacture it are at 5 Queen Victoria Street. The accompanying illustration—Fig. 9—will serve to give an excellent general idea of the construction of the apparatus. There is a central vertical tube inside a circular tank. Round the central tube, and reaching to the inside of the larger tank, are convolutions of sheet metal placed at an angle and a short distance apart, so that water supplied to the top of the central tube and issuing from its bottom must, in its upward course to the overflow, travel round the convolutions. It is stated that by the time it reaches the top the whole of the matter in suspension has been deposited,

The apparatus is self-contained, doing its own lime and carbonate of soda mixing, and regulating the amounts of these added to the water to be purified in proportion to the amount of this water.

The second apparatus, the invention of Herr W. Beissel, of 55 Beresford Road, N., is very much on the same lines as the foregoing. As will be seen from the illustrations, Figs. 10 and 11, the water has a number of alternative paths, all of the same length, instead of a series of convolutions where the possible paths are of varying length. Fig. 11 represents a cross section of the purifier proper, and Fig. 10 a general perspective view of the whole apparatus. There is the same central tube, *a*, as in the other system, which rests on a grating, *l*. This grating also extends to the sides of the inverted cone, forming the bottom of the main tank. Outside the central tube are fixed in a tier, one above the other, a number of funnel-shaped divisions. These are so arranged as to form conical annular spaces of equal size through which the water can circulate. The object aimed at is to have every path for the water of the same length, for example, the paths represented by the dotted lines, *m, o, p, q; m', r, s, q'; m², n, v, q²*. There is thus no chance of any stagnation, the whole of the water being in motion, and since there are no paths of progress which are shorter than others, the whole mass of water is equally dealt with, and, it is claimed, even and efficient results are obtained. The deposit of the insoluble carbonates and other foreign matter collected on the inclined surfaces, gradually slips down these, conglomerating as it goes, and falls down on to and through the grating, *l*, attracting numbers of particles to itself in its passage. Care has to be exercised in adjusting the flow of water so as not to exceed the capabilities of the apparatus, but when once adjustment has been made the process of purification is said to be continuous, the water coming away perfectly clear. Of the actual relative efficiency of these two systems we are unable to give any personal opinion. We can merely put before our readers the facts which have been presented to us.

There are several features which are shared by both systems, and which are of considerable interest. They are so nearly alike in both cases that if we describe the apparatus as applied to one purifier this will be sufficient. In Fig. 10 the pipe, *g*, is the supply of hard water, or of water which it is desired to purify—for it is claimed that other impurities than the lime and magnesia salts are removed from the water in the course of the process. This pipe, *g*, supplies water to a water wheel, *c*, and also through a cock and pipe, *e*, to the lime-mixing tank, *f*. The main volume of water—that which drives the water wheel—is then led into the tube, *a*, by the pipe shown, the amount passing through the pipe, *e*, being directly proportional to this. The tank, *b*, holds a solution of carbonate of sodium, and the arrangements indicated by *h* and *i*, which are worked by floats, automatically determine the amount of chemicals which are to be added to the water—the amount being accurately regulated in direct proportion to the amount of water flowing. If the water is cut off, then the supply of chemicals is cut off also. The lime mixture is made by means of the stirrer worked through the bevel gearing by the water wheel, and it flows from the top of *f* into the tube, *a*. The cocks, *x* and *k*, are for removing sludge from the lime-mixer and water purifier respectively. The action of the apparatus is simple. Enough lime is put into *f* to insure a solution of proper strength. The soda tank, *b*, is filled up to a certain mark with water, and a given quantity of the salt added. The cocks, *k* and *x*, are opened for a short time to let out the sludge formed during former operations, and all is ready for further work. The water is then turned on through the water wheel, and the apparatus works automatically till the soda tank is emptied—this may be arranged for a day or some such period of time. It is claimed that the replenishment of this tank and of the lime mixture, together with the flushing out of the sludge, constitute the only attention which the apparatus requires, and that for lengthened periods it may be left to itself.

THE GASES OF THE ATMOSPHERE.*

A DISTINGUISHED chemist who has added more to our knowledge of the atmosphere than any other living man, has said that to write the history of the development of our knowledge of atmospheric air would be to write the history of physics and chemistry. While this remark is not, of course, to be taken literally, yet it is true nevertheless that the beginnings of physics and chemistry coincide in a large measure with the early investigations of the atmosphere; and it is true, also, that progress in the study of the atmosphere has steadily kept pace with the advance of the two sciences I have named. The subject is not by any means exhausted at the present time; for wonderful discoveries have been made in it within the last few years. It is on account of these investigations that I have chosen the subject of this lecture wherein I propose to tell you how the gases of the atmosphere were brought to light.

According to a doctrine which originated with the Greek philosopher Aristotle, all material things were considered to be made up of four definite substances or elements, which were supposed to impart to these bodies various fundamental properties; the four elements were, as we know, earth, fire, water and air. So far as we can understand the writings of Aristotle and his followers we do not take it that these elements were substances in the present sense at all; they were rather carriers of the properties which were attributed to them and which they communicated to the substances into the composition of which they entered. Thus, earth was supposed to be cold and dry; fire, hot and dry; water, cold and wet; and air, warm and moist. This doctrine was universally accepted by all (that is, by all who were interested in such subjects) until about the middle of the seventeenth century, and some remnants of this doctrine survive even yet; some remnants, indeed, can be traced to the present time in our land.

As an illustration of how this doctrine was applied to the explanation of natural phenomena I will quote a passage from an Anglo-Saxon manual of astronomy, written a thousand years ago: "There is no corporeal thing which has not in it the four elements; that is, air and fire, earth and water. Take a stick and rub it on something; it becomes hot directly with a fire that lurketh in it. Burn one end, then goeth the moisture out of the other end with a smoke;" and I may add to this that the ascending smoke, and the ashes that remain after the wood is burned up, were considered to prove the presence in the wood of air and earth.

Strange as this doctrine may seem to us at this present day it endured longer than any other philosophical feature. Its overthrow is accredited to Robert Boyle, who published in 1661 a book advancing convincing arguments that these elements of Aristotle (and I may say also those which had been added by the alchemists) were not; as he puts it, "Cannot be regarded as certainly primitive and simple bodies, which not being made up of other bodies or of one another are the ingredients of which all those called perfectly mixed" (we should say "combined") "bodies are compounded and into which they ultimately result." I will repeat in modern language what Boyle said; this view of an element that he expressed in the words I have just quoted is tantamount to saying that elements are substances out of which two or more different substances have not been obtained. That is our modern definition, and agrees perfectly well with the statement of Boyle. Any substance which we cannot split up into two other substances, or have not been able to do, we call an element. It is to Boyle, also, that we are indebted for one of the most remarkable early attempts to ascertain the nature of the atmosphere. In his "Memoirs" he sets forth reasons for considering air to be a mixture of at least three kinds of corpuscles; and he attempts to explain its action on burning substances and proposed numerous experiments by which the theory might be advanced. The very complete programme laid down was never carried out. He did not succeed in establishing the composition of air, nor in ascertaining what part it plays in the process of respiration and combustion. He was, however, one of the most profound scientists of his time besides being one of the earliest investigators of the air. His Irish fellow-countrymen erected a monument to him bearing the inscription: "Robert Boyle. He was the father of chemistry and a brother of the Earl of Cork."

The first steps along the lines indicated were taken by Boyle's contemporary, John Mayow, an English physician. He wrote a treatise in Latin (published in 1674) wherein he endeavors to prove that air consists of two or three kinds of particles. By close observation and acute reasoning he is led to believe that only one of these constituents (which he calls the neo-aerial particles) is necessary for supporting life and the burning of inflammable substances, and that the other, which remains after its active constituent is removed, is incapable of supporting respiration or combustion. He asserts that fire-air enters the blood during respiration and is the chief source of motion in plants and animals. He shows that saltpeter and various acids contain this fire-air; that it is this constituent which is absorbed when a burning candle is placed in air and held over water and the other constituent of air is lighter than the fire-air. He argues that a combustible cannot burn in absence of air unless it contains gunpowder. Mayow communicated these results to the Royal Society; but it seems he made no impression whatever on his contemporaries, for the results of his work, which agree so marvelously with later views, were entirely forgotten when a hundred years later and more a greater mind, equipped with a more comprehensive knowledge, forced these same views, or very similar ones, on the scientific world.

At the time of Mayow's death at the age of 35 four things may be considered to have been established with certainty with regard to the nature of air: First, that it consists of matter, and that it therefore possesses weight and exerts pressure upon the surface of the earth; second, that it is a fluid, though much different from other fluids, such as water, in that it has a spring or elastic power; that is, it will yield to external pressure, but regains its original volume when external pressure is released; third, that it is not an element, but is composed of at least two kinds of particles; fourth, that it is in some way connected with the processes of respiration and combustion (but it was not explained just how).

More than half a century elapsed before any other progress was recorded. In 1727 Stephen Hales published some essays on vegetable studies in which he gives "A specimen of an attempt to analyze the air by a great variety of experiments;" and he describes with great length his observations on the influence of air on the growth and development of plants. From our point of view this book is of interest, inasmuch as it shows that Hales had made very great progress in the study of gases; that he was a very skillful experimenter who devised new processes of making gases and also to a certain extent of studying these gases. We still follow out his example in using the separate generators and vessels for collecting gases. He obtained a large number of the gases which we know now; but his prejudiced mind was unable to conceive that these other gases were different from atmospheric air; he merely regarded them as modified air, and he speaks of air as "A chaos, consisting not only of elastic, but also of unelastic particles." We need in Hales' researches the guiding hand of theory; and nowhere perhaps in the history of science is the value of theory more clearly demonstrated than in the subsequent development of our subject. However, preacher and botanist as he was, he was one of the greatest scientific experimenters of his time—his work on the "Rise of Sap in Plants" being still considered a classic in botany.

About the time that Hales published his book a very remarkable though erroneous theory, intended to explain the nature of combustion and allied phenomena, had come to be generally accepted. The theory of phlogiston originated with a German philosopher Johann Joachim Becher; but it was further developed and definitely formulated by his countryman, Georg Ernst Stahl, who assumed that all combustible bodies are compound bodies containing phlogiston which makes its escape while the substance is burning and the rest makes its escape in the form of a powder or gas.

A sound theory takes into consideration all the facts which it professes to explain; and the theory of phlogiston had a weak spot in that it was known that these calces or acids formed from a burning substance weigh more than the substance before it is burned. If phlogiston escaped into the air, how is it possible that the residue should weigh more than the substance did before? These facts had been established some fifty or a hundred years before the time of Stahl. The improved facilities in the way of experimentation (provided by Hales) and other causes renewed the study of the gases of the atmosphere. During the second half of the eighteenth century the leading investigators directed their researches mainly along this line; important discoveries followed; different kinds of air or gases were obtained and carefully studied; atmospheric air was recognized as the mixture of such gases, and the relative amounts of these were also accurately ascertained; and finally the chemical changes in which the atmosphere takes part; that is, the phenomena of combustion, respiration and calcination, were carefully explained. This period in chemistry, therefore, has appropriately been called the "pneumatic period"—the air period. The great discoveries made form the foundation upon which has been reared the great edifice of chemical science.

I desire to dwell more particularly upon some of the recent discoverers. Five great names stand out boldly among those of the chemists of the pneumatic period—Joseph Black, Joseph Priestley, Daniel Rutherford, Henry Cavendish, and Antoine Lavoisier. Of these, the four first named may be said to have contributed the principal discoveries of facts; while to Lavoisier, who was scarcely inferior to them as a great experimentalist, belongs the honor of having given a true interpretation of their results. Before the middle of the eighteenth century no aeriform fluid or gas had been clearly distinguished from the atmospheric air; the gases which Hales and others had obtained were regarded as modified airs, differing from ordinary air much as natural water differs from the distilled. The discovery by Black in 1751 of "fixed air," or carbon dioxide, was the first instance of a gaseous substance to be recognized as differing from air and at the same time one of the first constituents of the atmosphere. Black obtained it from magnesia alba. He heated the substance in a bent gun-barrel and collected the gas given off over water. In 1755 he published his celebrated thesis entitled "Experiments on Magnesia Alba, Quicklime and Other Similar Substances," in which he establishes the nature of carbon dioxide as a distinct substance and proves that small amounts of it exist in the air.

Black was a most methodical gentleman and a very great investigator. He did not publish much; and though he was a practitioner of medicine he made his chief contributions to physics and chemistry. Being at a table with some parties and having a cup in his hand, when the last stroke of the pulse was to be given he set it down on his knees, which were put down together and kept steady, and in this attitude expired without spilling a drop and without a wrinkle in his countenance, to show his friends the facility with which he departed.

In 1766 an important paper was published by Cavendish under the title of "Fictitious Airs;" it contains among other things the first account of inflammable air, afterward called hydrogen. This gas was made by the action of acids upon metals; and its discoverer, an adherent of the phlogistic theory, expressed the opinion that it either was or contained phlogiston. While this turned out to be erroneous, Cavendish describes very accurately the principles of the new gas, and characterizes it as an individual substance; many years later recognized it as an element; and quite recently a French chemist has proved that the atmosphere contains a very small amount of this gas.

In 1772 Cavendish discovered another gas, "mephitic air" (afterward called nitrogen), and almost simultaneously Daniel Rutherford, an Edinburgh physician, discovered the same gas in exactly the same way—they passed ordinary air over glowing charcoal and then removed the carbon dioxide by means of caustic potash. Another gas was left which did not support combustion (but it would burn); which did not turn lime water turbid, and which was not absorbed by potash. That was the "mephitic air" or nitrogen. For many years after Rutherford's discovery nitrogen was known under the name "phlogisticated air."

Henry Cavendish was a most peculiar and eccentric man. Having inherited a large fortune, he invested a good deal of it in philosophical apparatus and made wonderful discoveries, both in chemistry and physics; otherwise he was parsimonious. His French biographer said of him: "He was the richest of the learned and most learned of the rich," which was true. A famous piece of apparatus he used was the eudiometer, by which he tried to analyze air. It was a pear-shaped vessel of glass, in which a mixture of air and hydrogen was exploded by means of a Leyden jar.

The discovery of the most important constituent of air, that is, oxygen, followed next. It was made independently by Scheele in Sweden and by Priestley in England. Without hesitation it may be said that the discovery of oxygen marks the beginning of scientific chemistry. It is interesting to compare the ways by which Priestley and Scheele arrived at the same results. Priestley was a clergyman who found relaxation in experiments. He discovered a great many different gases; he greatly improved the apparatus that are used by chemists in experimenting with gases; he introduced, for instance, the pneumatic trough and also the mercury trough for collecting gases; but he lacked in scientific acumen. Scheele, on the other hand, was a born investigator, who conducted his experiments with definite ends in view and whose acute intellect was able to deduce the true meaning from their results.

These differences are clearly reflected in the writings

* Abstract of lecture delivered by Dr. H. F. Keller, of the Boys' Central High School, Philadelphia.

of the two chemists. Here is Priestley's account: "Having procured a lens, I proceeded with great alacrity to examine by the help of it what kind of air a great variety of substances would yield, putting them into vessels filled with quicksilver. On the endeavor to extract air from red oxide of mercury I presently found out by means of this lens air was expelled from it very readily. Having gotten about three or four times as much as the bulk of my material I admitted water to it and found it was not imbibed by it; but I found that a candle burned in this air with a remarkable increase of flame. I was utterly at a loss to account for it." In contrast with this haphazard way of experimenting Scheele is led to the discovery of oxygen in the course of a research in which he seeks to establish a theory of the nature of fire. In his famous treatise on "Air and Fire" he shows that air consists of at least two kinds of elastic fluids, one of which—the vitiated air or nitrogen—remains; and the other, which he calls "fire-air," has been removed by combustion, respiration or by chemistry. He described how this fire-air or oxygen can be obtained by heating various substances such as red oxide of mercury; and then goes on to prove that ordinary air consisting of the two kinds of elastic fluids can be compounded again after these have been separated from each other. He shows conclusively that oxygen made from calces is identical with that in air, and determines the principal properties in this gas. He estimates the relative amounts of oxygen and nitrogen in the air, and describes many other interesting observations on the respiration of animals.

Karl Wilhelm Scheele was one of the greatest investigators next to Cavendish—or with Cavendish the greatest; in fact, there is no doubt that Scheele made more important contributions to chemistry than any man that ever lived, and it is simply wonderful to contemplate that, because he was a very poor man, hampered by imperfect apparatus (he collected most of the gases he experimented on in bladders), by a lack of time, and he died young. He was better known abroad than he was in his own country; so that when the King of Sweden visited France and was complimented on having so sagacious a scientist in his kingdom he did not know whom was meant. Turning to his courtiers he got no response, and he directed that a medal or decoration should be bestowed upon Scheele. The decoration was bestowed, but it was bestowed upon a lieutenant of the guards who was a good swordsman but not a scientist.

The greatest difficulty during the pneumatic period must largely be accredited to the phlogistic theory. The sway of this theory continued unbroken while Scheele and his English contemporaries made the great achievements narrated; but not only did this absurdity dominate the mode of thinking—it dominated the mode of expression. It would be quite impossible now for us to read intelligently a chemistry of those times; just as no one could hope to make much headway in the chemical literature of to-day without having mastered the atomic theory, which is the basis of our chemical philosophy. It is to the genius of Lavoisier that we owe the overthrow of the phlogistic theory. Even prior to the discovery of oxygen and before the exact composition of air and water had been ascertained this master mind was able to denounce the phlogistic doctrine. Experiments of his own on the calcination of metals enabled him to tell that only one of the constituents of air, namely, oxygen, is capable of supporting combustion, while the other (nitrogen) is incapable of supporting combustion. He succeeded in converting most of his contemporaries to his views. The new chemistry undertook to explain, and with complete success, all the facts of a chemical nature known in those days, and its essential features have stood the test of experience till the present day. In 1789 Lavoisier published a book, a model to all those since writing on the subject. He states his facts with emphasis, clearness, and in a language from which the terms of the discarded doctrines have been rigidly excluded. He showed that respiration is a process of slow combustion in which oxygen is consumed and carbonic acid exhaled with an unconsumed portion of the oxygen and nitrogen.

Antoine Lavoisier was undoubtedly one of the greatest minds that the world has ever possessed. He was truly the father of chemistry. The foundations of scientific chemistry were laid by him; the main principles of scientific chemistry originated with him. He was born in Paris, and received a splendid education and devoted most of his life either to scientific research or to public duties. His public duties led him to an untimely, tragic death. Having married the daughter of a collector of revenues he himself became the incumbent of the office, and during the French Revolution was accused, along with forty others, of having misappropriated the public money. He was thrown into prison and condemned to be guillotined in public. The plea which he made to be permitted to finish his research for the good of mankind was denied with the brutal words: "The republic needs no scientists. Let justice take its course;" and he was guillotined the following day. His wife helped him a great deal in his scientific researches, which included the proof of the indestructibility of matter and the correct explanation of the phenomenon of breathing. The lens played a great part in Priestley's and Lavoisier's researches on the source of heat. In Priestley's case these experiments were very similar to those we make to-day.

I have yet to speak of one of the most important researches on the composition of the air which was in progress while Lavoisier's ideas were taking shape and which largely contributed to making these ideas known to science. I refer to the classical experiments on air which Cavendish published in 1784 and 1785. In these researches by one of the greatest experimenters the world has known the atmosphere was proved to have a definite composition, the relative percentages of oxygen and nitrogen being determined with marvelous accuracy. While Priestley and the others had come to the conclusion that air collected in various kinds of weather and in different localities varies in composition, Cavendish found as the result of a large number of analyses, having removed the carbon dioxide, that air contains: Nitrogen, 79.16 per cent; oxygen, 20.84 per cent; that is, very nearly 79 per cent of nitrogen and nearly 21 per cent of oxygen—results which differed but very slightly from those of the best modern analyses. In the course of these investigations Cavendish made other discoveries of far-reaching consequence. He showed that water is not an element but a compound, consisting of hydrogen and oxygen; he determined the quantity of hydrogen and oxygen in it, and also that of nitric acid; and he obtained argon, although he did not recognize it as a special gas. With the labors of Cavendish and Lavoisier the investigation of the atmosphere was for some time regarded as practically completed. The mysterious element of Aristotle and chaos of Hales had been determined as a mixture of definite proportions of oxygen and nitrogen. The chemical changes which take place when combustible substances burn in the air, when metals are calcined in it and animals breathe, were clearly understood.

In 1804 Humboldt made a very large number of experiments with gases collected in various parts of the world, in different altitudes and all kinds of weather, employing a method of analysis different from that of Cavendish, but with results agreeing very closely. They established constant composition. Now constancy of composition had been shown to be essential to chemical compounds, and was it not likely that the constituents of air were a chemical compound rather than merely a mixture? Further experiments by Gay-Lussac show that gases combine in simple proportions—one volume of one to one volume of the other; one volume of one gas perhaps to two of the other; perhaps one volume to five of the other. The theory of Dalton which had been announced to the scientific world required that the elements contained in a compound should be either in the ratio of their atomic weights or simple multiples of them. On this basis there should have been 22.2 oxygen instead of 23 of oxygen by weight. There is either a rise or fall in the temperature, they found, and generally an appreciation in the volume; but no such changes were noticeable when air was artificially made by mixing the constituents in the proper proportions. It was evident, then, that air is a mixture and not a compound, nor are the proportions absolutely unvarying. By the aid of a still more refined method Bunsen in 1846 succeeded in detecting slight variations in the proportions of the constituents of atmospheric air. The percentage of oxygen varied between 20.84 and 20.96—only one-tenth of 1 per cent, but very distinct.

The composition of air cannot remain constant, and yet other gases besides those I have mentioned must be present in it. Consider the many agencies constantly at work to deprive it of its oxygen—the respiration of man and animals, the burning of fuels, the decay of animal and vegetable matter, to mention but a few; consider, too, the many gases generated on this earth of ours! Must we not fear the air we breathe may in time become so poor in oxygen and so rich in other gases as to threaten our very existence? There is little doubt that even a slight variation in the proportion of oxygen may seriously affect all human beings as they are constituted at present. You need entertain no fears of an approaching oxygen famine, nor that the candle of life will be snuffed out some day by the accumulation of carbonic acid in the air. The oxygen consumed in various ways is in a large measure, if not entirely, restored to the atmosphere by the growth of plants which, under the action of sunlight, assimilate the carbon of carbonic acid and reject the oxygen it contains; but even without this compensating factor the shrinkage in the supply of oxygen would be almost inappreciable. It has been estimated that allowing for the oxygen consumed by man and animals and counting that required by combustion as four times this amount, it would be eight thousand centuries before the atmospheric reservoir would be depleted of its oxygen. As to the carbonic acid contained in the air, its proportions remain nearly constant—about three parts in about ten thousand. The aggregate amount is stupendous: it would supply the entire vegetable world with carbon.

Quite a number of other constituents (mostly in very minute quantities) were discovered by the chemists of the nineteenth century, among which is a curiously modified form of oxygen known as ozone, first obtained by Schoenbein. It possesses the power of destroying noxious gases and the germs of disease. Its purifying effects upon the atmosphere have been grossly overrated, for its amount does not exceed one part per million. Air also contains traces of nitrous and nitric acids. It is from these nitrogenous substances that plants derive much of the nitrogen that they require for the development of their structure and food—the free nitrogen of the atmosphere not being available for that purpose except in a few special cases.

Previously to 1894 it was the general belief among scientific men that the composition of air was certainly one of the subjects upon which their knowledge was most complete. This belief was rudely shaken by the announcement in that year by Lord Rayleigh and William Ramsay that a new gaseous substance was discovered by them. The great interest awakened by this find was greatly enhanced by the fact that the stranger could not be received in any of the old established families of elements, being entirely without affinity; wherefore it was named argon, "the idle one."

In one of his great memoirs entitled "Experiments on the Air," Cavendish described the effect of the electric sparks on measured volumes of air in the presence of caustic alkali confined in mercury. A specimen of air was confined over mercury and electric sparks were sent through that air while a little caustic potash was introduced. He noticed something peculiar in the result, and on successively adding small portions of oxygen while the sparks continued to pass, he found that the volume was still further diminished until finally only a very small fraction of the gas remained. Cavendish pondered the cause of the shrinkage. He says, "If there is any part of the phlogistic" (nitrogenous) "air which differs from the rest, it is not more than 1-170th of the whole." More than a century elapsed before the problem was determined. In 1883 Lord Rayleigh was greatly puzzled by the observation of the differences in the densities of two specimens of nitrogen which he had prepared. One of the specimens had been made from ammonia (compounded of nitrogen and hydrogen) and it was lighter than the other which he had obtained from the air. The difference was small, but distinct: 201 measures of chemical nitrogen were found to weigh as much as 200 measures of the atmospherically derived, and many experiments established the constancy of this difference. One or both preparations of the gas must contain some impurity, he thought. A most searching investigation failed to reveal the presence of even traces of any other known gas than either one of the nitrogen preparations; nor was it possible to obtain the slightest evidence that the atmospheric gas had been developed to any modified form. No one could give an explanation of the difference in the densities.

Ramsay now asked to make some experiments, and it was granted. Having discovered that magnesium (a silver white metal) slightly absorbs nitrogen in a certain condition, he proceeded to apply this experience to some nitrogen. As the volume of the gas diminished (the absorption being exceedingly slow) the density was found to increase. This encouraged Ramsay to repeat the experiment on a larger scale, and by the aid of elaborate apparatus in which the gas was made to circulate for days over the heated metal he succeeded in absorbing all but a very small volume, which proved to be half again as heavy as nitrogen. He mixed the residue of the nitrogen with oxygen and exposed the mixture to a rain of electric sparks in the presence of caustic alkali. Further contraction ensued, and when the rest of the oxygen was finally removed, a gas having a density twenty times as great as hydrogen and one-half again that of nitrogen remained.

Did this gas contain any of the known elements? The only way was to examine it spectroscopically. Ramsay's gas when thus examined was found to still contain nitrogen; for it showed the numerous bands characterizing this element; but it gave, in addition, many lines, mostly red and green, which could not be identified with any known element. The two discoverers agreed to go into partnership to make a final examination. By means of improved apparatus they were enabled to isolate argon from air in considerable quantities, and obtain it free from nitrogen.

Its density is 19.94, about twenty times as heavy as hydrogen. The rate of speed at which sound travels through this gas argon proves that it has molecules, unlike those of the commoner elements, consisting of one atom—not two. The molecules of oxygen, nitrogen and hydrogen are diatomic, and those of argon are monatomic. Argon differs from all other elements, being absolutely lacking in chemical affinity; it has steadfastly maintained its independence. Neither prolonged exposure to the most powerful electric discharges nor contact with the most active chemical substance has effected the slightest response of a chemical nature.

Science is knowledge reduced to system; the more advanced our knowledge grows the more advanced will be this system. This system will also provide, to a great extent, for the fitting in of new discoveries. These can often be foretold from gaps in this system, without which the progress of the nineteenth century would have been impossible: it formed a scheme in which all the known elements have found a place, and in which the prediction of certain processes arose from certain gaps. Gallium was discovered years ago—rather, the fact that such element must have been in existence. Ramsay was very anxious to find the place of argon in the periodic system. As it showed no resemblance to any of the members of the groups which constituted the system, there was no gap in this group in which it could be made to fit. The difficulty served to induce Ramsay to continue his investigations and thus led him to the discovery of the companions of argon: inert gases resembling argon and, like it, constituents of the air.

Ramsay believed it possible that compounds of argon might very well exist in nature and he instituted a diligent search for sources of the gas other than the atmosphere. His attention was directed to a remarkable observation which had been made in the laboratory of the Geological Survey in Washington by Dr. Hillebrand. By treating clevite with sulphuric acid this chemist had obtained a colorless gas which he believed to be nitrogen. Ramsay obtained considerable quantities of the mineral and extracted the gas in the hope of obtaining argon with it. To his great surprise the lines which he observed, though very brilliant, were not those he expected to see, but those of an element for which chemists had vainly been searching this earth for many years. It was during the eclipse of 1868 a French astronomer had noticed these lines in the spectrum of the sun's chromosphere, which had been attributed to the presence of an unknown element, helium. The existence of the element helium was thus proved, and no time was lost by Ramsay in making known its existence. It turned out that helium bears the closest resemblance to argon. Like the latter it is an odorless, colorless gas, but it differs from argon not only in its spectra but in its density, having a density only one-tenth as heavy, and next to hydrogen it is the lightest substance known.

The pronounced resemblance in their properties, together with the relation observed between the atomic weights, made Ramsay suspect that helium and argon are the members of a more numerous family. In 1897 he ventured the remarkable prophecy that there should therefore be an undiscovered element between helium and argon with an atomic weight of sixteen units higher than that of helium and twenty units lower than that of argon and that this unknown element should prove to consist of monatomic molecules and—following the analogy still further—it was to be expected that this element should be as indifferent to unite with other elements as were the two allied elements. A systematic search for this hypothetical element was at once begun; and after many unsuccessful experiments the missing link was found and the prediction fulfilled in every particular.

Gases can be converted into liquid by lowering the temperature in some cases only a little and gradually increasing the pressure; while in other cases intense cold and great pressure must be applied at the same time. The liquefaction of air can only be accomplished by reducing the temperature to say, 300 deg. F. below zero and applying a pressure of about 500 pounds

to the square inch. Until 1895 such conditions could only be brought about at great expense, and the liquefaction of air and other difficultly liquefiable gases had been conducted on a small scale. In that year a process was invented whereby air could be liquefied at small expense, and in considerable quantities. Ramsay used especial instruments devised for this purpose—using them for the double purpose as a refrigerant for liquefying argon and to see whether the liquid argon itself would not yield up some of the undiscovered element. On distilling the liquid obtained from about four gallons of argon gas, it was discovered that a gas lighter than argon passed over; and on still boiling, gases heavier than argon were distinguished. The spectroscope was again called to aid, and no difficulty experienced in recognizing three new elements: the lightest gas called neon, "the new one;" and of the two heavier ones, one was called krypton, "the hidden one," and the other xenon, "the stranger." The mixture we call the atmosphere contains of the five following elements these proportions: 9.37 parts of argon per hundred; 102.2 parts of neon per hundred thousand; one or two parts of helium per million; about one part of krypton per million; and about one part of xenon in twenty millions: it is therefore the rarest element known.

So far as we can see at the present time these five new elements serve no useful purpose. Oxygen keeps everything alive; nitrogen restrains the activity of oxygen; carbon dioxide, ammonia, nitric acid and nitrous acid are necessary to the growth of plants; vapor of water plays a grand part in those important and never-ceasing changes we call the weather; and even ozone contributes its share of usefulness in freeing the atmosphere from deleterious matters; but no apparent benefit to the living world can be instanced as the result of the presence of argon and its associates in the air. While this is an unsatisfactory admission with which to conclude my story, let us bear in mind that, after all, we know but little of the secrets of nature, and that future investigations will tend to modify largely the results of the past.

ETHNIC STYLES IN CENTRAL AMERICAN ARCHITECTURE.*

By Stephen D. Peet.

The most interesting point of resemblance between the architecture of the Muskogees and of the Aztecs and Toltecs, is found in the temples or so-called rotundas, or places of assembly. The rotundas of the southern tribes were, to be sure, constructed out of wood and were rude in their appearance, and yet when we come to consider their shape and general style of construction, the symbolism which was embodied in their ornaments, carved figures, also the general arrangement of the different parts and the use of them, especially in connection with their religious ceremonies, we shall find many very striking analogies.

These rude and primitive temples, which were called rotundas, with their covering of bark and their circle of seats or sofas on which the inmates lounged, with the fire in the center, were indeed very inferior to the massive stone structures which were wrought with such care and contained so many religious symbols, and yet we may perceive a resemblance between every part, for both represented apparently the great temple of the universe with its circular horizon and the dome of the sky surmounting it, the sacred fire being in the center beneath the dome and the lightnings playing in the form of serpents between the earth and sky, while the sun with its changes shone in from the four quarters. The symbolism which is contained in these great houses and rotundas of the southern Indians is certainly very significant, especially considering the fact that they so closely resembled that which prevailed among the so-called civilized people of Mexico and Central America, for it shows that they had contact with one another and may have belonged to the same stock, and originally migrated from the same center. There was, to be sure, as we have said, a variation in the style of building between these tribes, but it was a variation which was more noticeable in the houses of the common people than in the houses of the rulers or in the rotundas. Bartram describes these as being the same among the Cherokees, Choctaws and Chickasaws.

The feature which furnishes the most striking resemblance between the works of the southern Indians and those of the Mexican tribes, and at the same time shows the greatest contrast to the earthworks of the northern Indians, is the pyramid.

The pyramidal mounds mark the site of an ancient village of the southern mound builders, a village in which the houses of the chiefs were placed above those of the common people, all of them arranged in a quadrangular form, but with stairways leading from them to the open area in the center, while a long wall stretches away from the group on the side of the stream or bayou, thus furnishing a landing place for the people in time of high water. The truncated pyramids at Teotihuacan, on the other hand, mark the site of an ancient, prehistoric city, which was situated in a great plain. The houses of the ruling classes in this city, however, were arranged as were those of the village. They were all placed on the summit of the pyramids, but in quadrangles, all of them front-

COLUMNS AND HALLS AT XKICHMOOK, YUCATAN.

STAIRWAY AND HALLS, EDIFICE NO. 3, AT XKICHMOOK.

* American Antiquarian.

ing the courts, which were inclosed, while a wide road, called the "Pathway of the Dead," led from the central temple to the gateway in the distance. The contrast between the village of the mound builders and the city of the pyramid builders seems to be great, yet the foundations on which the two widely separated peoples placed their temples and the houses of the ruling classes are very similar.

This resemblance between the works of the southern mound builders and of the pyramid builders of the southwest, can hardly be accounted for on the ground of ethnic relationship, inasmuch as the people at present speak different languages. Still there are traditions among the Muskogees to the effect that their ancestors migrated from the west and southwest, from the mountain of fire, and entered the region of the Gulf States many generations ago. That there was a resemblance in the arrangement of the apartments of forming the quadrangle, and the division of each into apartments, is shown in the accompanying plan."

The resemblance extends to other things besides the shape, and relative situation of the buildings, for the social organization and customs were quite similar. Bartram says:

"The mounds and cubical yards seem to have been raised in part for ornament and recreation, and likewise to serve some other public purpose, since they were always so situated as to command the most extensive prospect over the town and country adjacent. The tetragon terraces seemed to be the foundation of a fortress, and perhaps the great pyramidal mounds served the purpose of lookout towers and high places for sacrifice. The sunken area was the place where they burnt and tortured the captives, and was surrounded by a bank—sometimes two of them, one behind and above the other—which were used as seats to or king, was elected by a council, but was regarded with great respect. His appearance is altogether mysterious; as a munificent deity, he rises over them as the sun rises to bless the earth; he is universally acknowledged to be the greatest person among them, and is loved, esteemed and reverenced. Their Mico seems to them the representative of Providence, or the Great Spirit. He has the power of calling a council to deliberate on peace or war, and presides daily in the councils, either at the rotunda or public square, and decides upon all complaints and differences. He receives the visits of strangers, gives audience to ambassadors, and also disposes of the public granary.

"There is, in every town or tribe, a high priest, who presides in spiritual affairs, and is a person of consequence. He maintains and exercises a great influence in the state, particularly in military affairs. The senate never determines on an expedition against their

STAIRWAY AND RUINED TEMPLE AT XKICHMOOK.

RUINED PALACE OF XKICHMOOK, YUCATAN.

the great house of the Muskogees and the apartments of the palace of the Mayas, may be seen from the cuts, which represent the ground plan of the palace called the Nunnery, at Uxmal, and the restoration of the palace of Palenque. Bancroft has described the Nunnery as follows:

"This is perhaps the most wonderful edifice or collection of edifices in Yucatan, if not the finest specimen of aboriginal sculpture and architecture in America. The supporting mound is, in general terms, 350 feet square and 19 feet high, its sides very nearly facing the cardinal points. The southern or front slope of the mound is about 70 feet wide and rises in three grades or terraces. There are some traces of a wide central stairway, leading up to the second terrace. On the platform stand four of the typical Yucatan edifices, built around a courtyard, with openings between them and the corners. The situation of the four structures accommodate the spectators at such tragical scenes. The high pyramidal mounds are to be seen with spacious and extensive avenues leading from them to an artificial lake, or pond of water. Obelisks, or pillars of wood, were placed in the center of the areas, about forty feet in height and two or three feet in diameter, gradually tapering in the midst of an oblong square. The pillars and walls of the houses of the square are decorated with various paintings and sculptures, with men in a variety of attitudes, having the head of some kind of an animal, as those of a duck, turkey, bear, fox, wolf or deer; and the pillars in front of the council house were formed in the likeness of serpents."

There was not only a rotunda and a public square, answering to the temple and the palace of the more civilized tribes, but there were also priests and kings, which answered to the ruling classes. "The chief, enemy without his counsel and assistance. His influence is so great as to turn back an army when within a day's journey of their enemy."

SALTS OF GLUCINIUM.

M. LACOMBE, in a paper read before the Académie des Sciences, describes a number of new salts of glucinium which he has succeeded in preparing. The acetate of glucinium, having the formula $(C_2 H_3 O_2)_6 Gl_4 O$ has been already formed by him, and the new series are homologous with the acetate; thus he forms a group including the formiate, acetate, propionate, etc. All these compounds are of the type $R_6 Gl_4 O$, where R represents the radical of the fatty acid. They are formed by the action of an excess of a fatty acid upon carbonate of glucinium. The presence of a trace of water is necessary to provoke the reaction,

but a large quantity of water should not be used. As all these salts are volatile, the best method of purifying them is by distillation under reduced pressure. The first bodies of the series are solid and well crystallized, but their fusing points diminish when passing from one term of the series to its superior homologue, and the terms having a high molecular weight are liquid. The boiling temperature shows a progression in the inverse sense. It will be remarked, however, in the following table, that there is a curious anomaly on the part of the boiling point of the isobutyrate of glucinium, which is below that of the propionate.

Series.	Fusing Points.	Boiling Points at Normal Pressure.	Boiling Points at 19 mm. of Mercury.
Formiate of glucinium.	Sublimes without melting.	—	—
Acetate	283—284 deg. C.	330—331 deg.	Volatilizes without melting.
Propionate	119—120	339—341	221
Isobutyrate......	76	336—337	216
Butyrate, normal	liquid	—	239
Isovalerate	liquid	—	254

The formiate is insoluble in all dissolvents, while the acetate is scarcely soluble when cold except in chloroform. The propionate is also insoluble in all the solvents employed, such as alcohol, ether, benzene, chloroform, etc. M. Lacombe is continuing his researches upon these new compounds.

PROBLEMS OF ELECTRIC RAILWAYS.*

By J. SWINBURNE and W. R. COOPER.

INTRODUCTION.

THE electric railway has now been with us for a decade, and it has recently been developing rapidly in America and on the Continent. The first steam railway in this country to change is going to be converted to electric haulage as soon as the work can be carried out; and there is great activity in the direction of building "tubes."

In all cases it has been taken for granted that the constant potential system which is employed for street tramways is correct for railways; and the development is going rather in the direction of turning railways into big high speed tramways. In many cases it has been considered that the railway of the future is to be a sort of glorified tramway with single, and perhaps double, cars running at frequent intervals, or at sight.

One of the most dangerous results of the present development is that engineers are equipping individual railways without considering the effect on railways as a whole. If electric railways become general, as there is no doubt they will very soon, uniformity in gage is not enough; we ought to have uniformity of electric supply, both as to pressure and current, and as to nature of supply, such as direct, alternating, or three-phase. If alternating or three-phase is used, the frequency should be standardized also.

It is proposed in this paper to urge for consideration the claims of series distribution of power for railways, especially for short lines, such as the tube and suburban types.

The steam locomotive is an admirable machine for its purpose. It can give a great torque at starting without undue waste of energy; and it can reduce the torque at full speed if desired, and run economically. This machine, however, is being replaced by the constant pressure motor, which can be made to give any torque desired, certainly; but which gives it only at great expense of power at starting.

URBAN LINES.

Urban lines are characterized by a very varying load, the largest number of passengers being carried between the hours of say eight to ten in the morning and five to seven in the evening, the trains being comparatively empty during a great part of the day. It is essential that there should be a frequent service; and not only frequent, but sufficiently rapid to make it worth people's while to walk to and from a station rather than to take another means of traveling which is nearer at hand. If a frequent service of this kind is fairly patronized during the hours of low load, then during the hours of heavy load the line is almost certain to be unable to cope satisfactorily with the traffic. This is seen in the case of the Central London Railway.

To increase the capacity of a line, the best course, and in some cases the only course, is to raise the mean speed. This enables a more frequent service to be run without increasing the number of trains or the staff; there is, however, an increased load on the generating station. But in many cases this is only a small objection, because the cost of the generating and distributing plant is a small part of the total, and the cost of fuel is only one, and not necessarily the most important, of a number of items which go to make up running costs.

Consider, for example, the results obtained on the Central London Railway. Here the capital to December 31 of last year was £3,681,313, and the train mileage for the year was 1,243,730, so that 5 per cent on this capital amounts to 35.5d. per train-mile, which represents the difference that should exist between receipts and expenditures to provide this dividend on the train-mileage quoted. A figure of this kind has not yet been reached. At present the mean speed is about 22 kilometers (14 miles) per hour, or 15½ miles per hour including stops, the length of the line being 9.2 kilometers (5¾ miles) with thirteen stations. The average stop at stations is about 15 seconds. It is noticeable that the time taken for the train to come to rest after the locomotive reaches the station is very considerable, being about 15 to 20 seconds. The average headway is from 2½ to 2¾ minutes at the busiest time.

Let us now consider the effect of running trains half as fast again during the heaviest hours of traffic, so that the time of headway is reduced. We will assume that the effect of this is to increase the traffic, and therefore the receipts, by 20 per cent. The increase in car mileage would not be so great if the service were uniform all day, because the increased speed will be maintained only during the heaviest hours, say four hours per day, and will be unnecessary on Sundays; but as the number of trains on the line is greater during the busy hours, we will take 20 per cent as the increase in train mileage also.

The accounts of the last six months, to December 31, are given in the accompanying table in the first three columns, while in the last two are given the accounts as modified by the assumed increase in traffic. In calculating these modified figures certain items may be considered as constant—for example, salaries. Thus the maintenance of way will not increase by as much as 20 per cent, the increase being chiefly in wages and materials. The locomotive and generating expenses would increase 20 per cent if the speed remained constant, but as the speed is higher we will assume the fuel to be increased 25 per cent, making allowances for lifts, or by £3,400, and about £750 to be added on account of oil, water, etc., and repairs, bringing the total to £39,000. The figure for repairs is increased to £5,500. The increase in the traffic expenses would be small, being chiefly in connection with the lifts, and therefore the sum of £34,681 is increased only to £35,000. The remaining items may be regarded as constant. We therefore arrive at a total of £95,983, or 31.23d. per train mile. The revenue, allowing 20 per cent on receipts, becomes, say, £202,000, or 65.74d. per train mile. The expenditure is therefore reduced from 53.8 per cent to 47.5 per cent of the receipts, and the percentage of profit to capital for the half-year is increased from 4.3 per cent to 5.76.

It may be objected that this high-speed service cannot be run without adding to the generating plant and distributing system throughout. But if a considerable sum, say £85,000, be spent for this purpose, and the wages be increased by, say, £1,000 for the six months, the percentage of profit to capital for the half-year is still as high as 5.6 per cent per annum. The result is, therefore, very appreciable, even if additional plant is necessary.

TABLE I.

FINANCIAL RESULTS OF THE CENTRAL LONDON RAILWAY.

	Six Months to December 31 1901.			Modification by Increased Traffic	
Train Mileage	614,517			737,420	
	Total.		Per Train Mile.	Total.	Per Train Mile.
Maintenance of Way, Works, and Stations.	£	£	d.	£	d.
Maintenance of Way ... Wages	2,173				
Maintenance of Way ... Materials	609				
Repairs of Structure, Stations, etc. ...	976				
Salaries, Office Expenses, and General Superintendance	332	4,180	1·634d.	4,500	1·46d.
Locomotive and Generating Power.					
Coal and Coke	13,664				
Wages	9,830				
Oil, Water, Gas, and Stores	1,895				
Repairs and Renewals ... Wages	3,839				
Repairs and Renewals ... Materials	1,914				
Salaries, Office Expenses, and General Superintendence	1,519	32,661	12·760d.	36,800	11·98d.
Repairs and Renewals of Cars.					
Salaries, Office Expenses, and General Superintendence	100				
Cars ... ... Wages	1,463				
Cars ... ... Materials	783				
Lifts .. .. Wages	1,717				
Lifts .. .. Materials	769	4,838	1·890d.	5,500	1·79d.
Traffic Expenses.					
Salaries and Wages—Stations & Service	19,153				
Fuel, Lighting, Water, & General Stores	7,220				
Electric Lifts—Wages and Materials..	5,187				
Miscellaneous Expenses	3,121	34,681	13·550d.	35,000	11·40d.
General Charges.					
Directors	1,250				
Salaries of Secretary, General Manager, and Clerks	2,756				
Other Charges	2,510	6,516	2·546d.	6,516	2·12d.
Rents, Rates, and Taxes		6,535	2·553d.	6,535	2·13d.
Miscellaneous Items		1,132	0·442d.	1,132	0·37d.
TOTAL		90,543	35·375d.	95,983	31·23d.
Revenue		168,359	65·80d.	202,000	65·74d.
Excess of Revenue over Expenditure ...		77,816	30·425d.	106,017	34·50d.
Percentage of Total Expenditure to Revenue	53·8 per cent.			47·5 per cent.	
Percentage of Profit to Capital for the Half-year	4·3 "			5·76 "	

Let us now consider how a high mean speed is best attained. A journey may be divided into periods of acceleration, of running at more or less constant speed, of braking, and of rest at stations. Taking the last item first, it is only necessary to say that the periods of rest are very important when the distance between stations is short, and they become increasingly so as the mean speed is raised. In the case of the Central London Railway, the trains stop on the average about 15 seconds at each station, which amounts to 10 per cent of the total time. If people are in some way informed what the next station is going to be, a stop of 10 seconds is generally long enough, especially if the cars are arranged, as on the Metropolitan of Paris, so that a door at one end is used for entering the car and one at the other end for leaving.

The periods of acceleration, steady running, and braking are so closely connected together that we shall consider them all under the head of acceleration.

ACCELERATION.

Variation of Acceleration and Maximum Speed.—As far as economy of time is concerned, the higher the acceleration and retardation, and the higher the speed of steady running, the more satisfactory is the service. But the extent to which the acceleration can be increased is limited in three ways: (1) by discomfort reaching high acceleration may cause the passengers; (2) by increase in cost, and not merely in energy, but also in generating plant and the distributing system; and (3) by slipping, which can generally be avoided in practice.

Generally speaking, there is still a considerable difference between the accelerations and retardations used in electric traction. No discomfort is felt through rapid braking, and therefore there is no reason why an acceleration as high as one meter per second per second, or even higher, should not be used from the point of view of comfort. As far as convenience to passengers goes, it is not so much the acceleration as the time rate of change of the acceleration that is important. In the case of acceleration people are frequently standing, not having had time to find their seats. If an acceleration of say 0.8 meter per second per second is applied, a man standing vertically must lean 4½ deg. in the direction in which the train is going if he is to be in equilibrium. It should be clearly understood, however, that there is a difference between a train starting with a jerk and the acceleration starting suddenly. People that are standing should receive warning by a gradual increase of the acceleration.

The effect of varying the acceleration, retardation,

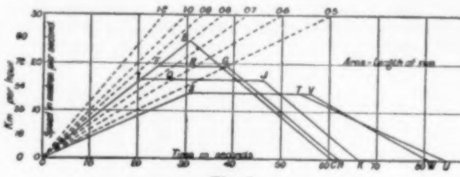


Fig. 1.

and maximum speed are best shown by working out an actual case.

We therefore assume a tube railway with stations 0.75 kilometer apart, and 17 stations, the line being 12 kilometers long. The stations would not in practice be equidistant; but for simplicity we will assume that they are so. We will take the weight of train at 100 tonnes, or 100,000 kilogrammes, and for convenience we will express the results in the decimal system.

Fig. 1 shows graphically the relations of some of the quantities we must deal with. The co-ordinates are speed and time. Constant acceleration is then an inclined straight line, and constant speed a horizontal straight line. The area of a curve or polyhedron is then the distance. The areas of all the curves should thus be equal to 750 meters.

The line O B represents uniform acceleration at 0.8 m/sec.². At B the time is 30.4 seconds, and the train is half-way. If it is retarded at 0.8 m/sec.² its motion is shown by the line B C, arriving at zero speed at 60.8 seconds. The maximum speed is 88 km. (55 miles) per hour. If the acceleration is stopped at a maximum speed of 70, the trace is O F G H. The difference is only a second and a half out of a minute,

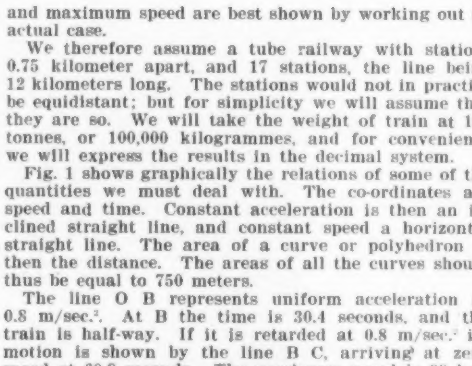


Fig. 2.

or out of 70 seconds including the time of stopping, which may be taken as 10 seconds. Taking the kinetic energy at B (*i. e.*, the energy used in acceleration) as 1, that along the trace F G is 0.633. Thus 58 per cent more energy is used if the maximum speed is raised from 70 km. per hour to the highest value possible under these conditions (88 km.), or there is a saving in energy of 37 per cent if the lower maximum speed is used, with a loss of only about 2 per cent in the time. If the maximum speed is further reduced to 60 km. per hour the trace O I J K is obtained, which takes four seconds more, but requires only 46.4 per cent of the energy taken by the trace with the peak B consisting wholly of acceleration and retardation.

In Fig. 2 there is a trace O D E shown. This is for an acceleration of 0.8 and a retardation of 1; and needs 58.23 seconds. The maximum speed is 93 km. per hour, needing 13.5 per cent more energy, and saving about 2 seconds. It is probably admissible to brake a little faster than to start up, and if electrical braking is used with the motors working at full load, the braking is more rapid than the acceleration in about this proportion. We will therefore adopt a retardation of approximately 1 instead of 0.8. O F L M and O I

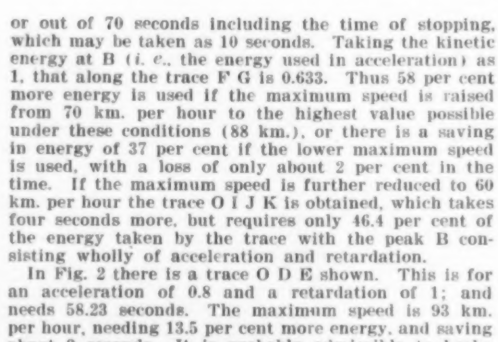


Fig. 5.

N P are the corresponding traces for maximum speeds of 70 and 60 km. per hour. There is obviously less saving of time in these cases, and neither the acceleration nor retardation are quite so important.

In the diagram Fig. 1, there are several dotted lines representing different accelerations. In practice it is impossible to run a train according to such a trace as O B C, because a certain time must be allowed for manipulation and errors of judgment. In practice, also, trains do not run at constant speed. They are always accelerating if current is on, and if they are coasting there is retardation.

The traces in Figs. 1 and 2 are drawn on the as-

* Abstract of paper read before the Institution of Electrical Engineers.

sumption that the acceleration reaches its full value at once. If the acceleration is raised gradually so as to give warning to the passengers, a trace is obtained like the dotted lines in Fig. 2, showing that there is a considerable loss of time.

Energy and Power Required for High Acceleration.—With a given maximum speed, assuming that coasting is adopted after this speed is reached, the energy is independent of the acceleration, the maximum kinetic energy of the train being by hypothesis constant. But if the maximum speed is increased, the energy used varies as the square of the maximum speed, so that the increase is rapid. This in itself, apart from the generating station, would not be important on an urban line where traffic could be created by a high-speed service.

The maximum power, on the other hand, varies directly as the acceleration for a given maximum speed, and directly as the maximum speed for a given acceleration; or, generally, the instantaneous power varies as the product of the acceleration into the speed. Since the power is constant if the acceleration varies inversely as the speed, economy in power would be effected by allowing the acceleration to diminish in the usual way after a certain time, instead of keeping it constant. The speed curve then would not rise so rapidly, after, say, half-speed had been reached; but the time so lost would be small, and would be readily made up if the top speed is allowed to exceed the assumed maximum, the only disadvantage being that rather more energy is consumed as the maximum speed is higher.

The only way in which a very large saving of energy and power can be effected is by means of electric braking and return of energy to the line.

The practical value of high acceleration has been shown very clearly by recent tests on the Liverpool Overhead Railway, particulars of which have been kindly supplied by the engineer, Mr. S. B. Cottrell. The total length of the line is 10.5 km. (6½ miles), with seventeen stations. Up to the present this distance has been run in thirty-two minutes, or at the rate of about 20 kilometers (12½ miles) per hour. Tests with new rolling stock have shown that this time can be reduced to 20.4 minutes, the time at stations remaining eleven seconds as before. The total weight of the train, including passengers, during the trial run was 16.3 tons, the total carrying capacity of the train being 154 passengers. The energy required increased from 250 kj. per tonne km. (110 watt-hours per ton mile) to 310 kj. per tonne km. (137 watt-hours per ton mile) or 6.35 units per train mile. The total cost of producing and transmitting this energy would be about 3d. per train mile. In Table IV. is given a summary of the results obtained.

TABLE IV.

RESULTS ON THE LIVERPOOL OVERHEAD RAILWAY.

	Old System.	Accelerated Service.
Mean speed	12½ miles (20 km.)	19¼ miles (31 km.)
No. of stops	16	16
Mean time at stations ..	11 seconds	11 seconds
Mean distance between stations	729 yards (666 m.)	729 yards
Watt-hours per ton mile	110	137
Acceleration	1·6 feet. (0·44 m.) per sec.²	3 feet (0·91 m.) per sec.²
Retardation	3 feet (0·91 m.) per sec.²	4·8 feet (1·26 m.) per sec.²

An average acceleration of at least 3 feet (0.91 m.) can be relied on, a maximum of over 4 feet (1.22 m.) having been recorded. Fig. 5 shows graphically the results obtained on a trial run between Brunswick Dock and Toxteth Dock on the Liverpool Overhead Railway. The gradients of the line are given on the distance diagram. There is only one curve, which is at the beginning of the third section.

The train used in these trials consisted of two motor cars and one trailer, each of the motor cars being equipped with two 75 kw. motors. A point of interest in connection with the motors (which are made by the English Electric Manufacturing Company, of Preston) is that they reached the unusually high efficiency of 93 per cent at the full load of 75 kw., and that their weight is 4,200 pounds, or only 42 pounds per horse power (25.4 kg. per kw.), which is a point of great importance in keeping down the dead weight of the train. With the motors, two in parallel, two in series, the current frequently rises to 700 or 800 amperes. The motors will carry 80 amperes continuously without overheating, but they carry three to five times that amount during periods of high accelerations.

We will now consider various systems and their suitability for urban railways.

PRESSURE.

As to the pressure, 500 volts has the advantage of being safe; but from the shareholders', and therefore in the long run from the passengers' point of view, it is more expensive in every way than a higher pressure. It is probable that the exigencies of transport will accustom us very soon to treating a railway as a dangerous thing. We do not prohibit the use of locomotives because they kill you if you get run over; people know that and keep out of the way. In the same way, when people understand that electric wires are dangerous at high pressure they will touch them at their peril. We will therefore assume a train pressure of 2,000 volts.

CONSTANT PRESSURE URBAN RAILWAY.

We may now go into a comparison of the systems by taking special examples. Merely to get something definite to go upon we may take 0.8 m. (2.62 feet) per sec.² as acceleration for the rapid trains we hope to travel in in the immediate future, and 0.4 m. (1.3 feet) per sec.² to get our comparisons into line with present day practice.

Case I.—At O (Fig. 7) the train starts with the motors in series, and 500 volts and 1,600 amperes, or 800 kilowatts. As time goes on, when half-speed time is reached, at A all the resistance is switched out, and the motors are giving 500 volts back pressure (neglecting the resistance of the motors). O B C D then represents the energy used in getting to half-speed. Of this the triangle O C D has been converted into kinetic energy, and O B C has been wasted in the resistances.

The motors are now put in parallel, taking 3,200 amperes or 1,600 kilowatts. The area D E F G represents the energy taken, and of this C E F is wasted on resistance, the rest being used. The total waste in starting is thus $^1/_3$. If the motors had not been put in series for the first half of the acceleration, the energy would have been twice D E F G and the waste ½, demanding 25 per cent more energy.

Case II.—The starting may be made more efficient by choosing a lower speed for cutting out the last of the resistance. Thus, if the controller is not altered at S the train would go on accelerating, though not uniformly, and this acceleration would be economical, as there would be no resistance waste. The acceleration would depend on the characteristic of the motor. For simplicity, let us imagine hypothetical motors without resistance, and with such permeable fields that the pressure varies as the speed and as the current. We

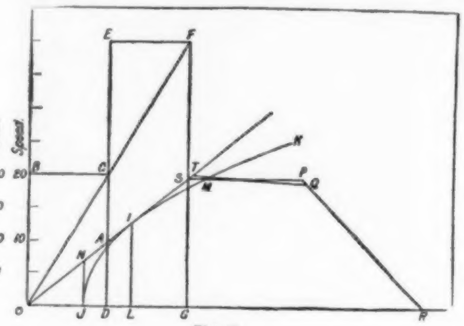


Fig. 7.

would then probably arrange the normal speed of the motors, that is to say, the speed at which they give 500 volts with 1,600 amperes at, say, L I. The acceleration curve of such motors on constant pressure can be shown to be a cubic J I K. Braking with these hypothetical dynamos would be impossible, as they would be unstable. We must therefore forego any return of energy by braking. Our total intake is $^{11}/_9$, or 1.22, but we return nothing, so we keep 1.22. Having regard to the size of the station, it is probably better to use 1.22 returning nothing than to draw 1.5 and return 0.5. Moreover, braking even with specially designed series machines would be very troublesome. Our return and efficiencies are also hypothetical, and too high.

Case III.—Shunt machines have been used for returning energy by braking at constant speed. Three-phase motors work as brakes in the same way, but merely as a convenient method of braking, not because the energy is valuable. But we may wind shunt machines, with weak fields, to have their normal current, and normal fields at I in Fig. 7.

The treatment from O to I is then the same as in the case of series machines. At I the machines are left on with no resistances. If left alone the trace would then start off on a horizontal line. But if the field is weakened by a rheostat controlled by the main current, the trace will follow the curve to M with the same results as to efficiency. On braking the motors are quite stable, and the braking trace is practically the reverse of the trace O I M. Again, taking the kinetic energy of full speed as 1, the motors return $^4/_9$ down the curved part corresponding to I M, and from I to N the return is $^3/_9$. From N to O it is, of course, zero. On this system the motors take in $^{11}/_9$ or 1.2, and return $^7/_9$ or 0.77, using $^4/_9$ or 0.44.

Case IV.—If a series motor is placed on a constant-current circuit, it requires no resistance for starting, and it is brought to rest by merely short-circuiting. The machine starts up with constant torque, and maintains this torque at all speeds so long as the current in the fields is not altered by shunting. Thus the usual form of controller is not required, and there are no controller losses. Consequently if urban railways could be run by series motors on constant current, one of the most serious causes of loss would be avoided. Moreover, if the armature of such a motor is reversed when running, it returns energy to the line; and since the current remains the same, the torque, on braking, is the same as for acceleration (neglecting losses); and therefore retardation is the same, and is maintained up to the point of stopping. Thus the motors take in 1, the waste is 0, and the return is 1.

We may compare the results so far obtained. Taking the kinetic energy as 1, we have:

	Taken.	Waste.	Return.
I. Series with electric braking....	1.5	1	0.5
II. Series without electric braking.	1.2	1.2	0
III. Shunt with electric braking....	1.2	0.4	0.7
IV. Series constant current system.	1	0	1

We will, therefore, select III. for our typical constant-pressure system, at least for high speeds on urban lines, in spite of its not being in use, as we thus give the constant-pressure system at least a very fair representation. It must be borne in mind that we have so far been discussing hypothetical motors without resistance; in practice nothing like these results can be obtained.

CONSTANT-PRESSURE RAPID URBAN TRAIN.

Case V.—We may now work out a more practical case of an urban constant-pressure equipment to fit the trace O F L M of Fig. 2 approximately. We will assume that the motors are shunt, and lose 4 per cent in their fields, 4 per cent in their armatures, and 8 per cent by mechanical losses, making an efficiency of 84 per cent at their normal speed and current.

Taking the train at 100 tonnes (98.5 tons) and the acceleration at 0.8 m/sec.² the pull is 8,000 megadynes (8,150 kilos, or 18,000 pounds). At the normal, or I of Fig. 7, we will take O to I, 15 seconds as a convenient round number, the corresponding velocity being 12 m/sec. (43 km. or 27 miles per hour). The power is then 8,000 × 1,200 × 10⁻⁴ kw., or 960 kw. At 2,000 volts this means 480 amperes. The motors must therefore give a torque on the axles equivalent to 960 kw. at 12 m/sec. (43 km. per hour). No allowance has yet been made for train resistance. We may take 250 kg. (5.6 pounds per ton), or, to make round numbers, 250 megadynes (255 kg., or 565 pounds) as the pull needed to overcome train resistance. At a speed of 12 m/sec., 250 megadynes are equivalent to 30 kw. The motors must therefore deliver 990 kw. to the axles at 12 m/sec. As the motor efficiency is 84 per cent, 1,178 kw. must be drawn from the line, or 589 amperes at 2,000 volts. For 7½ seconds, therefore, the motors take in 589 kw., and for 7½ seconds 1,178; and then we reach the point I, having taken in 13,250 kilojoules (nearly 3.7 units). From I to full speed, namely, 19.45 m/sec., means an increase of kinetic energy, which, with the traction, amounts to 12,000 kj. We may take this, at 0.84 efficiency, as 14,400 kj. (3.9 units). To go along the flat part of the trace by turning on the motors for a moment and coasting will take, say, 500 kj. Our total intake is thus 28,150 kj. (7.83 B.T.U.), and the kinetic energy is 18,900 kj.

On braking down to I the motors return approximately 9,600 kj. (2.67 units). During half the rest of the retardation the return is 2,940 (0.82 unit), making a total of 12,540 (3.5 units). So, taking the kinetic energy as 1, we take in 1½, waste $^5/_6$, and return $^2/_3$, which is approximately the same as our hypothetical but impossible Case I.

(To be continued.)

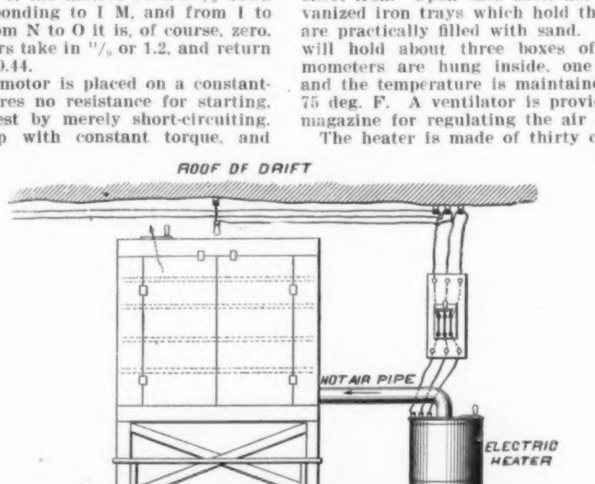
A NEW ELECTRIC THAWER.

As a result of the shocking accident which occurred in the Trade Dollar group of mines in Nevada on February 15 last, caused by the ever-dangerous powder thawing box, Chief Engineer E. F. Stewart of that company, with the assistance of a number of the employés, has completed what he calls the electric thawer. As the device is not patented, it is hoped that wherever electricity is used the thawer will be used.

The magazine or thawer is 5 feet long, 4½ feet high and 2 feet deep, and is set on a stand 22 inches above the floor of the drift. In it are four 1 x 12-inch shelves. The magazine is lined throughout with sheet iron. Upon each shelf are two 12 x 29-inch galvanized iron trays which hold the powder. The trays are practically filled with sand. The size given above will hold about three boxes of powder. Two thermometers are hung inside, one to check the other, and the temperature is maintained at from 70 deg. to 75 deg. F. A ventilator is provided at the top of the magazine for regulating the air currents.

The heater is made of thirty coils of No. 22 tinned steel wire, zig-zagged between the circular top and bottom plates of the stove. German silver wire is preferable for this purpose, on account of its greater resistance and less tendency to oxidize, but the tinned steel answers very well. The coils are inclosed with a drum of galvanized iron, several inches larger than the coil frame, and attached to the same with three bent legs of strap iron. This drum is open at the bottom. The top is made closed, with openings for the hot-air pipe leading to the magazine and also for a regulating damper. The heater stands on porcelain knobs, and the connections with the magazine are thoroughly insulated.

The electric current used throughout the mine is



ELECTRIC POWDER THAWER USED BY TRADE DOLLAR CON. MINING COMPANY.

of 400 volts, and the same is attached to the heater. An ingenious method is employed to illuminate the magazine with a 110-volt 16 candle power lamp. One wire of the lamp is attached to the 400-volt main, while the other is carried through a switchboard to the heater and attached to one of the resistance coils—a sufficient number of coils being cut in to equalize the high voltage. The lamp hangs in front of and just above the magazine, giving plenty of light for the man in charge.

In operation, from two to three hours are required to thaw the powder, when it is taken out of the trays and repacked in the powder boxes, to be used as required. By covering the boxes with gunny sacks, etc., the powder will remain thawed and in proper condition for use for several days.

Engineer Stewart would be glad to furnish any further fact that is in his power to give, and hopes that this simple device will do away with the old dangerous box and candles.

THE PERRET LIGHT-WEIGHT STORAGE BATTERY.

In the development of the automobile during the last few years, and in the rapidly growing desire for electric lighting on yachts and in carriages, there has been an urgent demand for storage batteries of moderate weight and relatively large capacity. Mr. Frank A. Perret took up the consideration of this problem some years ago, and succeeded in producing an entirely new type of storage battery which has now been in use upward of four years, with most encouraging results. In devising this type of cell Mr. Perret had in mind not only a reduction in weight and increase of capacity, but also a relatively high rate of charge and discharge, as well as simplicity, purity of materials, freedom from complex chemical reactions and a minimum of care in commercial use. This high aim has been accomplished, and four years' use of cells made in accordance with these principles has demonstrated their entire practicability and usefulness.

The Perret Storage Battery Company, to whom the invention was assigned, has been quietly at work during the last few years, reducing the same to practice and putting out batteries to demonstrate their claims in a commercial manner. Now, for the first time, a description and illustration of the Perret cell are made public.

The other desirable features of the Perret cell are simplicity, purity of materials, freedom from complex chemical reactions, together with a minimum of care required in commercial use.

MECHANICAL CONSTRUCTION.

The elements of this cell are made up of a number of units, each unit consisting of a rod of pure metallic lead, as seen in Fig. 1, all units being constructed alike, both as to material and workmanship, so they may be used, without selection, either for positives or negatives. Each unit is separately wrapped in a perforated hard-rubber envelope, and tied up with a specially prepared binding thread. A number of these units are burned together to make an element (Fig. 2), and are formed by the electric current in a bath of pure, dilute sulphuric acid.

For a single cell two single elements, such as are shown in Fig. 2 are used; but when there are several cells to be connected in series, two elements are burned together (Fig. 3) and are suspended over the tops of two jars placed closely together. Thus, in formation, one element becomes the positive in one cell, and the other element becomes the negative of the next cell. And so on throughout the series, single elements being, of course, employed for the terminal elements of the end cells.

Insulation and separation are well provided for. The perforated hard-rubber envelope and binding thread of each unit is supplemented by the horizontal hard-rubber straps on each element. In addition there is a perforated hard-rubber separator between the two

Fig. 3.—POSITIVE AND NEGATIVE PLATES, SHOWING METHOD OF CONNECTING CELLS.

elements, thus making altogether a sevenfold insulation between the lead surfaces of opposing units.

The danger of buckling is almost wholly eliminated in the Perret battery. Although the units forming an element are bound together by the horizontal straps, each unit is free to move to a certain extent and buckling is practically impossible, except under most violent conditions. Exceedingly severe tests have been made, but without an instance of buckling of any of the elements.

Another feature of this cell, which differs essentially from all other types of storage battery, lies in the fact that the elements do not rest upon the bottom of the cell, being in all cases suspended and supported from the top and having a clearance of from one-half to three-fourths of an inch from the bottom. This is important in automobile practice, and in all uses where batteries are subjected to jarring or vibration. The elements are thus protected from injury resulting from heavy shocks, or a succession of minor shocks.

CHEMICAL PURITY.

As above stated, each unit consists of a rod of metallic lead. This lead is as pure as can be obtained. The same idea of purity (freedom from admixture of other chemical ingredients) is maintained throughout the manufacture of the whole battery. Aside from the rubber entering into the mechanical part of the cell, there is nothing used in its construction or formation but pure lead, sulphuric acid and water. Consequently it is free from nitrogen, chlorine and other chemical compounds, thus insuring a long life and freedom from troubles which occur in many other batteries, by reason of chemical reactions arising from the presence of such compounds.

By reason of the purity of materials used, as well as the peculiar and compact construction, and the method of formation, the Perret cell has a high capacity for its weight. Its capacity is 12½ watt hours per pound of complete cell, including acid, at a discharge rate of 1.4 amperes per pound. The discharge curve at that rate is practically a straight line. The efficiency of the cell, like that of all other storage cells, rises, of course, at lower discharge rates. It is only fair to add that an efficiency of over 20 watt hours per pound of complete cell, has been obtained in experimental batteries, but this has not yet been reduced to commercial practice.

Besides the advantages comprised in decrease of weight and increase in capacity, the Perret cell may be recharged more quickly than the ordinary storage cell, and without injury. Ordinarily, the time for full recharging is four hours, although it may be accomplished in three hours, or even less on occasions where there may be special reasons for haste.

The field for a battery with the desirable characteristics of the Perret cell, is a large one, comprising not only electric, but also for sparking purposes in gasoline carriages, automobiles, and yacht and carriage lighting, as well as for dentists, physicians and surgeons, and indeed in all cases where a high power, readily portable storage battery can be used to advantage.

There is one entirely new field opened by the advent of a battery such as has been described, and that is electric lighting on sailing yachts. With 400 pounds of this battery, divided into groups and put up in readily portable boxes, a suitable number of electric lamps can be lighted for several nights and the batteries carried ashore and recharged in a few hours, at any port where there is an electric light plant.

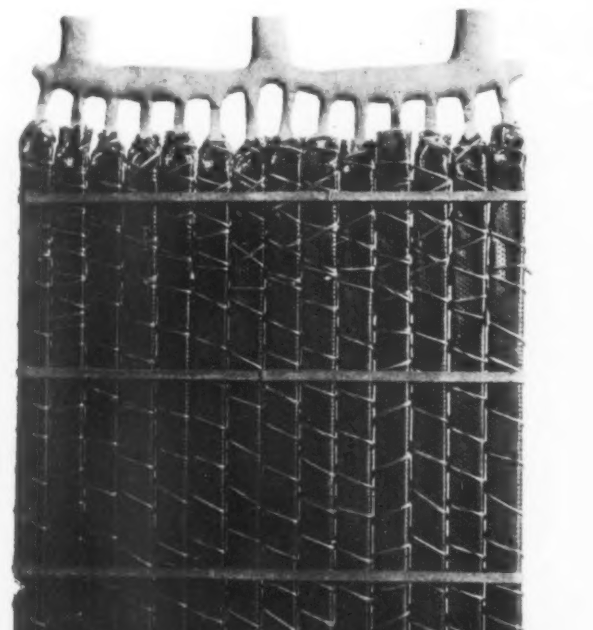


Fig. 1.—PERRET UNIT. Fig. 2.—UNITS ASSEMBLED, FORMING A PLATE.

SOME RECENT ELECTRIC FURNACE PRODUCTS.*

By Clinton Paul Townsend.

Although the pulverization of metals in the electric furnace forms the subject of several patents issued in this country and abroad, but little is known of the practical operation of the methods or of the nature or use of the several products obtained.

The general method is simple in the extreme. A metal is heated either by the arc or by the passage of a heavy current through a column of reduced cross section, and is thereby brought to the temperature of volatilization. Vapors so produced are, in most cases, directly combustible in air, burning freely to oxide, or may be subjected to various reagents with corresponding variety in the products; or, finally, the metal may be collected directly in comminuted form in an inert atmosphere. The applications of the method embrace the manufacture of a whole series of pigments, abrasives, refined metals, and miscellaneous reagents.

In 1896, the Société Civile d'Etudes du Syndicat de l'Acier Gérard, of Paris, patented abroad a method designed primarily for the production of steel from iron by a modified Bessemer process, the principal feature of which was the comminution of the metal before subjecting it to a graduated blast of air, the effect being, as in the converter, the oxidation of silicon, sulphur, phosphorus, and carbon, and the conversion of the pig metal into steel. As one method of pulverization, the employment of the arc was suggested, the fused metal falling in a stream between the circuit terminals and collecting after passing through an air blast in the hearth of the furnace.

Later, a modified construction was adopted wherein a metal formed a short circuit between water-cooled terminals, and the air blast was projected against its surface at the point of maximum temperature; the vapor was thereby oxidized, and carried over to a collecting chamber forming a part of the furnace.

The substitution of other metals for pig iron suggested at once several modifications of this process, to wit: the comminution of lead for use in accumulators; the production of litharge by the concurrent oxidation of the lead; the production of zinc as a sublimate, or, in the presence of an air blast, of zinc white; the production of rich mattes of copper, or the pulverization of this metal as a preliminary to the extraction of the contained values; the production of powders of bronze, tin, and aluminium, which enter in many ways into industrial processes; and finally the comminution of chrome—or tungsten—steels, to serve as abrasives.

An analogous procedure for the manufacture of white lead has been patented in this country to Messrs. Bailey, Cox & Hey. In this process the arc is struck from a tubular electrode to the surface of a mass of molten lead. Commingled vapors of water, carbon dioxid, and acetic acid, introduced through the hollow electrode, are presumed to react with the vaporized lead to form commercial white lead; the function of the acetic acid in this process is not clear and its use is probably merely a relic of various prior methods operating at temperatures at which the acid is stable.

Messrs. Bredig and Haber have noted in the Berichte a curious phenomenon, which occurs when the arc is struck beneath the surface of the electrolyte, either acid or alkaline, to a lead wire cathode, or when high cathode current densities are used under these conditions; the metal is disintegrated, appearing as a cloud in the solution, and white lead may, it is said, be produced by merely injecting air and

* Electrical World and Engineer.

carbon dioxid. The method is, of course, not a commercial one.

Recently M. Bary, of Paris, patented a furnace for the commercial production of stannic acid. The molten metal is included as a resistance in the circuit, and the vapors as they escape from an orifice in the furnace cover are ignited by an air blast, and the dioxid collected. The Tin Electro Smelting Company, Limited, of Paris, which controls this patent, is also marketing a series of pulverized metals, presumably made in an analogous manner. These are, an impalpable powder of tin, known in France as argentine, and capable of giving, by simple rubbing, a burnished foil-like surface to paper; several grades of pulverized aluminium, the finest constituting the base of a new high explosive, and the coarser grades adapted for use in thermite reactions, as, for instance, the reduction of oxide of chromium, etc.; and pulverized lead, employed for the manufacture of minium, of white lead, and particularly for the production of sodium nitrite.

CONTEMPORARY ELECTRICAL SCIENCE.*

SOLAR CORONA AND COMETS.—C. Nordmann regards the sun as the source of all kinds of electromagnetic waves, although many of these are absorbed by the atmosphere of the earth. The photosphere is probably the source of electromagnetic waves of great length as well as of light waves. Hertzian waves should be chiefly produced in the zone of sun spots and faculæ, and at the maximum of solar activity. Since the filaments of the corona are probably due to the pressure of light, the filaments should be shorter during a sun-spot period than at other times, and this is corroborated by observation. The incandescence of the upper portions of the sun's atmosphere cannot be due to heat alone, as it is particularly intense during a maximum of sun spots, when the surface radiation of the sun is reduced. It is, therefore, extremely probable that it is due to Hertzian waves, which are then at their maximum. The mechanical pressure of Hertzian waves is small. As regards comets, their spectra show that the incandescent gases of comets have a low temperature, something like that which obtains in discharge tubes. This fact identifies them with the incandescent gases produced artificially by means of Hertzian waves. As a comet approaches the sun its spectrum is changed in the same manner as that of a gas when the current intensity is increased.—C. Nordmann, Comptes Rendus, March 3, 1902.

MAGNETIC ACTION OF CATHODE RAYS.—A curious instance of the misinterpretation of experimental results is quoted by J. von Geitler against himself. Some time ago he described experiments which appeared to show that cathode rays exert an action upon a magnetic needle. But recent researches convinced him that this effect was simulated by a thermo-electric effect which he had not suspected. The various brass tubes which were used to protect the needle from electrostatic influences were provided with caps of rolled brass. In the place where the cathode rays impinged upon the tube, the latter was heated and gave rise to a thermo-electric current between the hot and cold portions of the brass. Owing to the small resistance the current was strong enough to deflect the needle. Moreover, it always flowed in such a direction as to produce the effect expected from the cathode rays. The thermo-electric current was, of course, the stronger the more intense the rays themselves, and was reversed with every reversal of the current through the discharge tube. The author, therefore, is driven to the conclusion that his former results are untenable quantitatively and possibly also qualitatively.—J. von Geitler, Physik. Zeitschr., March 15, 1902.

ANNUAL AURORAL PERIOD.—In middle latitudes the frequency of the aurora borealis shows a double annual period, with maxima at the equinox and minima at the solstice. C. Nordmann furnishes an explanation which depends upon no assumptions, except that the sun's influence upon the atmosphere is the determining factor, and that the effect is the stronger the longer the atmosphere is exposed to the sun's rays. At the equinox, the great circle of the earth which separates day from night is normal to the equator, whereas at the solstice this circle is inclined at an angle of 66 deg. 33 min. to the equator. Hence the portion of the illuminated atmosphere which in a given time passes from day into night—i. e., from one side of the terminator to the other—occupies a band along the terminator whose breadth is l at the equinox, and l sin 66 deg. 33 min. or 0.9 l at the solstice (l being the arc through which the earth turns in a given time). Hence the proportion of auroras at equinox to auroras at solstice should be as 10:9. A further disproportion is introduced by the fact that the terminator is not sharp, and that the twilight is longer at the solstice than at equinox. This makes the proportion 10:8, which closely agrees with observation.—C. Nordmann, Comptes Rendus, April 1, 1902.

DISCHARGE POTENTIALS.—According to M. Toepler, there are 10 different forms which a discharge in air between a point and a plate can assume, and their occurrence depends upon the difference of potential and current strength, as well as the distance between the two electrodes. The main element of interest in all measurements connected with discharges through gases is the limiting potential at which the visible discharge sets in. The discharge begins, even at the lowest P.D.s, probably on account of the natural ionization of the air. The first visible discharge which sets in on increasing the current is a spark discharge, and the same author has made a special study of the potential at which this discharge sets in. He has brought out a remarkable discontinuity in the variation of the initial discharge potential with the distance between the electrodes. The curves giving the relation between these two elements are all bent at a point corresponding to a distance between electrodes amounting to about five times the diameter of the anode disk. As regards the limiting difference of potential of the positive brush discharge, it is nearly equal, whether the supply of electricity to the electrodes is constant or intermittent. It is also independent of the capacity of the circuit within wide limits, as may be easily proved by introducing a condenser. A remarkable fact brought out is that the limiting potential of the positive brush discharge is practically independent of the size of the anode from which the brush discharge proceeds.—M. Toepler, Ann. der Physik, No. 3, 1902.

WAVES EMITTED BY THUNDERSTORMS.—F. Larroque has made some further studies of Hertzian waves emitted by lightning flashes over enormous distances. The sparks observed to pass between the two portions of the vertical antenna were only a few microns long, and had, therefore, to be studied under a microscope. An interesting fact elicited was that the waves arriving from a great distance are practically horizontal. The antenna may be shortened to zero without producing any effect upon the spark, but the removal of the horizontal plate at the top of the antenna makes the sparks disappear. When, on the other hand, the storm is in sight, or at all events not further off than 200 miles, the contrary holds good, and the waves are more vertical than horizontal. The author raises the question whether the waves received at long distances are reflected, refracted, diffracted, or secondary, but does not answer it except by saying that diffraction must be excluded. He endeavors to throw some light on it by experiments with a single vane mounted in a Crookes tube, and counterpoised by a small glass weight. The vane places itself parallel to the axis of the tube under the influence of electromagnetic waves. The author ascribes this to the Maxwell-Bartoli pressure of radiation.—F. Larroque, Comptes Rendus, March 10, 1902.

ELECTRIC OSCILLATIONS IN COILS.—After the example of Hertz, it is usual to produce electric oscillations with the aid of sparks. But oscillations may also be obtained by simply closing or opening a circuit in which a coil of a sufficient number of turns is inserted. The period of these oscillations may be calculated from the capacity, inductance, and resistance of the circuit containing the coil, and their existence may be proved by means of a coherer. This has been done by Emil Lüdin, who simply attaches a coherer to some part of the circuit by one end, and measures the resistance after each break or make. He found that the effect is greater at break than at make. By substituting a long wire for the coherer and mounting another wire parallel to it, he was enabled to demonstrate the existence of longitudinal waves in both wires. If a coherer is attached to the end of the second wire, its resistance falls as soon as the current is closed or opened in the primary circuit. But the strength of the resonance depends upon the length of the second wire. A progressive shortening or lengthening of the wires shows successive maxima of resonance about 18 meters apart. —E. Lüdin, Ann. der Physik, No. 3, 1902.

* Compiled by E. E. Fournier d'Albe in The Electrician.

THE PARIS-NICE HEAVY-WEIGHT AUTOMOBILE ENDURANCE TEST.

OUR illustrations show some of the heavy buses and a weighty automobile that participated in the trip from Paris to Nice the first part of last month. Out of fourteen omnibuses, trucks and delivery wagons that started eleven completed the journey, covering daily the distance planned and everywhere proving an interesting curiosity to onlookers. This heavy vehicle test was organized by La France Automobile, and it had the official sanction of the Minister of War, who appointed as judges the officers seen in our illustration. The Minister of Agriculture offered a medal to any manufacturers who should use alcohol in place of gasoline, but, notwithstanding this offer, not a single vehicle used it. The trouble is said to be that no perfectly reliable alcohol carbureter has been invented, and none of the manufacturers was willing to risk employing alcohol in a critical test of this kind. An endurance and speed test is to be run off shortly, however, with alcohol automobiles alone. This Northern Circuit test already has nearly one hundred entries, some of the makers putting in as many as a dozen machines.

THE DE DIETRICH GASOLINE OMNIBUSES AND TRUCKS IN THE PARIS-NICE HEAVY-WEIGHT AUTOMOBILE ENDURANCE TEST.

One of the most interesting features of the Paris-Nice caravan was the Turgan-Foy steam tractor, which hauled four loaded wagons, weighing, inclusive of the tractor, 22 tons, the entire distance, although requiring a week more than the other vehicles (18 days in all), on account of numerous mishaps and unfavorable circumstances, such as an inundation of the Rhone, which stopped them from crossing it, and suspension bridges that would not hold the weight, thus making detours necessary. Rainy weather was encountered nearly all the way, thus giving the vehicles much to contend with.

A climbing contest between a Daimler and a Dietrich truck at Monaco was another interesting feature at the end of the run. Starting at 7:30 A. M., the two trucks reached La Turbie, situated at an elevation of 1,775 feet above Monaco, at 9:19, including two 5-minute stops. They left La Turbie at 9:29 and reached the fort at the top of Mont Agel at 11:11, thus covering the distance of 5½ miles on an average grade of 8 per cent in 1 hour and 42 minutes, which corresponds to a mean speed of about 3¾ miles an hour. The vertical distance traversed from La Turbie to the summit was 2,296 feet. The Daimler truck carried a load of 3,240 pounds and consumed 2.59 gallons of gasoline, while the Dietrich truck carried a 3,395-pound load and consumed 3.66 gallons. This remarkable performance shows that gasoline trucks can be built that will carry heavy loads to high altitudes in short times and at very small expense. As a concluding feature of the heavy-weight endurance test, it was an industrial revelation.

Captain Gentry. Colonel Lambert. Commandant Mengin. Commandant Ferrus.

THE MILITARY OFFICERS APPOINTED AS JUDGES OF THE FRENCH HEAVY-WEIGHT AUTOMOBILES, IN THEIR GARDNER-SERPOLLET STEAM TOURING CAR.

THE UNVEILING OF THE ROCHAMBEAU STATUE.

Following hard upon the visit of Prince Henry of Prussia to the United States, came another event of international importance. The event in question was the unveiling of the Rochambeau statue, presented to the United States by the Republic of France.

Immediately in front of the White House at Washington is Lafayette Square, which takes its name after the famous French general, who placed his sword at the disposal of the American colonies during the Revolution. At one corner of this square stands a monument erected to the memory of Lafayette. At the diagonally opposite corner stands the statue of Rochambeau.

Rochambeau's statue, which is of bronze and of heroic proportions, is the work of Ferdinand Hamar, and is a replica of that erected in France. Naturally the most prominent feature is the figure of the general himself, dressed in the full uniform of his rank, his arm extended in the attitude of command. A symbolic figure on the pedestal expresses the sentiment and meaning of the monument. The figure of a woman representing liberty, with drawn sword in one hand, extends a protecting arm over the American eagle. In the left hand of the figure the entwined flags of France and the United States are held. The prow of a ship in the background suggests help from over the sea. Further down is displayed the shield of the United States, bearing the thirteen stars of the original colonies.

THE ROCHAMBEAU STATUE AT WASHINGTON.

LAUNDRY BLUES.

The "soluble blue" of commerce is much used, we believe, for laundry work, and may of course be dispensed dry if desired.

This blue, when properly made, dissolves freely in water, and solutions so made are put up as liquid laundry blue. The water employed in making the solution should be free from mineral substances, especially lime, or precipitation may occur. If rain water or distilled water and a good article of blue be used, a stable preparation ought apparently to result; but whether time alone affects the matter of solubility we are unable to say. As it is essential that the solution should be a perfect one, it is best to filter it through several thicknesses of fine cotton cloth before bottling; or if made in large quantities this method may be modified by allowing it to stand some days to settle, when the top portion can be siphoned off for use, the bottom only requiring filtration.

The soluble blue is said to be potassium ferri-ferrocyanide. If the pharmacist wishes to prepare it himself, instead of buying it ready made, he may do so by gradually adding to a boiling solution of potassium ferricyanide ("red prussiate of potash") an equivalent quantity of hot solution of ferrous sulphate, boiling for two hours and washing the precipitate on a filter until the washings assume a dark-blue color; the moist precipitate can then at once be dissolved by the further addition of a sufficient quantity of water.

About 64 parts of the iron salt is necessary to convert 100 parts of the potassium salt into the blue compound.

Leaf bluing for laundry use may be prepared by coating thick sized paper with soluble blue formed into a paste with a mixture of dextrin mucilage and glycerin. Dissolve a given quantity of dextrin in water enough to make a solution about as dense as ordinary sirup, add about as much glycerin as there was dextrin, rub the blue smooth with a sufficient quantity of this vehicle and coat the sheets with the paint. The amount of blue to be used will depend of course on the intended cost of the product, and the amount of glycerin will require adjustment so as to give a mixture which will not "smear" after the water has dried out and yet remain readily soluble.

Ultramarine is now very generally used as a laundry blue where the insoluble or "bag blue" is desired. It is mixed with glucose, or glucose and dextrin, and pressed into balls or cakes. When glucose alone is used, the product has a tendency it is said to become soft on keeping, which tendency may be counteracted by a proper proportion of dextrin. Bicarbonate of sodium is added as a "filler" to cheapen the product, the quantity used and the quality of the ultramarine employed being both regulated by the price at which the product is to sell.

As the mixing and compression process is somewhat troublesome, it may pay better to purchase the balls or cakes from the manufacturer or jobber in large packages and put them up from these into small cartons, as this operation will usually yield much of the profit to be derived from the sale.

Anilin blues are also used it is said in laundry work. In an article in the London Laundry Record, it was said: "The coal tar blues are not offered to the general public as laundry blues, but laundry proprietors have them frequently brought under their notice chiefly in the form of solutions, usually 1 to 1½ per cent strong. These dyes are strong bluing materials, and, being in the form of solution, are not liable to speck the clothes. Naturally their properties depend upon the particular dye used; some are fast to acids and alkalies, others are fast to one but not to another; some will not stand ironing, while others, again, are not affected by the operation; generally they are not fast to light, but this is only of minor importance. The soluble, or cotton blues, are those most favored; these are made in a great variety of tints, varying from a reddish-blue to a pure blue in hue, distinguished by such brands as 3R, 6B, etc. Occasionally the methyl violets are used, especially the blue tints. Blackley blue is very largely used for this purpose, being rather faster than the soluble blues. It may be mentioned that a 1 per cent solution of this dye is usually strong enough. Unless care is taken in dissolving these dyes they are apt to produce specks, which is not desirable."

It was stated in the article referred to that the heat to which the pure blues are exposed in ironing the clothes causes some kinds to assume a purple tinge.

The cheapest anilin blue costs say, roughly, three times as much as "soluble blue," yet the tinctorial power of the anilin colors is so great that possibly they might afford a solution of the cheapening question.—Drug. Circ. and Chem. Gazette.

SELECTED FORMULÆ.

Varnish for Bottles.—Bottles may be made to exclude light pretty well by coating them with asphaltum lacquer or varnish. A formula recommended for this purpose follows: Dissolve asphaltum, 1 part, in light coal tar oil, 2 parts, and add to the solution about 1 per cent of castor oil. This lacquer dries somewhat slowly, but adheres very firmly to the glass.

Asphaltum lacquer may also be rendered less brittle by the addition of elemi. Melt together asphaltum, 10 parts, and elemi, 1 part, and dissolve the cold fused mass in light coal tar oil, 12 parts.

Amber colored bottles for substances acted upon by the actinic rays of light may be obtained from almost any manufacturer of bottles.—Pharmaceutical Era.

Blue Indelible Ink.—

Crystallized nitrate of silver	1 drachm
Water of ammonia	3 drachms
Crystallized carbonate of sodium	1 drachm
Powdered gum arabic	1½ drachms
Sulphate of copper	30 grains
Distilled water	4 drachms

Dissolve the silver salt in the ammonia; dissolve the carbonate of sodium, gum arabic, and sulphate of copper in the distilled water, and mix the two solutions together.—Pharmaceutical Era.

Foot Powder.—

Salicylic acid	7 drachms
Boric acid	2 ounces, 440 grains
Talcum	38 ounces
Slippery elm bark	1 ounce
Orris root	1 ounce

Glycerin Tonic.—

Extract of gentian	10 grammes
Fluid extract of taraxacum	50 c.c.
Tincture of cinnamon	50 c.c.
Tincture of cardamom	10 c.c.
Phosphoric acid, U. S. P., '90	10 c.c.
Glycerin	400 c.c.
Sherry wine, a sufficient quantity to make	1,000 c.c.

Dissolve the extract in the wine, add the other ingredients and filter.

Antiseptic Dentifrice.—

Boric acid	50 parts
Salicylic acid	50 parts
Dragon's blood	20 parts
Calcium carbonate	1,000 parts
Essence spearmint	12 parts

Reduce the dragon's blood and calcium carbonate to the finest powder, and mix the ingredients thoroughly. The powder should be used twice a day, or even oftener, in bad cases. It is especially recommended in cases where the enamel has become eroded from the effects of iron.—Pract. Drug.

Dressing for the Hair.—

Oil wintergreen	20 drops
Oil almond, essential	35 drops
Oil rose, ethereal	1 drop
Oil violets	30 drops
Tincture cantharides	50 drops
Almond oil	100 grammes

Mix. —La Medecine.

Balsamic Cough Sirup.—

Balsam Peru	2 drachms
Tincture tolu	4 drachms
Camphorated tinct. opium	4 ounces
Powdered extract licorice	1 ounce
Sirup squill	4 ounces
Sirup dextrine (glucose) sufficient to make	16 ounces

Add the balsam of Peru to the tinctures, and in a mortar rub up the extract of licorice with the sirups. Mix together and direct to be taken in teaspoonful doses.

Koumys Substitute.—To prepare a substitute for koumys from cow's milk, Prof. Zobloff gives the following directions: Dissolve 15 grammes (½ ounce) of grape sugar in 120 c.c. (3 fluid ounces) of water. Mix 1.2 grammes (18 grains) of well-washed and pressed beer yeast with 60 c.c. (2 fluid ounces) of cow's milk. Mix the two liquids in a champagne bottle, fill with milk, stopper securely and keep for three to four days at a temperature not exceeding 10 deg. C (50 deg. F.), shaking frequently. The preparation does not keep longer than four to five days.—Apoth. Zeit.

Tasteless Chill Tonic Mixture.—

Cinchonine (alkal.) crystals	4 drachms
Iron by hydrogen (red. iron)	½ drachm
Sodium bicarbonate	½ drachm
Orange flower water	1 ounce
Dextrine sirup (glucose)	6 ounces

Directions: Shake thoroughly and take a teaspoonful every three hours until the chills are broken, then a teaspoonful three times a day after eating.—Pract. Drug.

Driffield Oils.—

Barbadoes tar	1 ounce
Linseed oil	16 ounces
Oil turpentine	3 ounces
Oil vitriol	½ ounce

Add the oil of vitriol to the other ingredients very gradually, with constant stirring.—Pract. Drug.

Gold Indelible Ink.—

Make two solutions, as follows:

1. Chloride of gold and sodium	1 part
Water	10 parts
Gum	2 parts
2. Oxalic acid	1 part
Water	5 parts
Gum	2 parts

The cloth or stuff to be written on should be moistened with liquid No. 2. Let dry, and then write upon the prepared place with liquid No. 1, using preferably a quill pen. Pass a hot iron over the mark, pressing heavily.—National Druggist.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

British Demand for American Shooks.—Under date of October 23, 1901, I reported an increasing demand for American shooks.* The publicity given to the subject resulted in considerable activity on the part of American exporters, and the growth of the business has been phenomenal. Relations between the American sellers and the English buyers, as well as the experiences of box makers and consumers, have not, however, been entirely satisfactory, owing chiefly to the failure of our exporters to meet the exact requirements of the English market. As the market for American shook lumber, not only for return to the United States, but for Continental, colonial, and even local use, is almost illimitable and practically undeveloped, a statement of general requirements as to size, price, quality, etc., will answer many independent inquiries. American sellers, to do satisfactory business, must adopt the English system of measurement in their correspondence and quotations. This is made clear by the attached table, which also gives current prices in English values. In order to secure a practical English view of market conditions, I talked with a number of buyers, box makers, and consumers. Mr. Henry Cutts, Bentinck Buildings, Wheeler Gate, is a leading lumber agent or broker with considerable American experience. He said, substantially:

"Your methods of selling by superficial measurement are not understood by the majority of our case makers. Our terms of purchase and sale are by the 'standard,' as shown by the table (referred to above). For lace shooks, the standard is 720 feet lineal of 3 by 11 inches. This measurement is equal to 1,980 feet superficial, 1 inch thick or 2,640 feet superficial three-fourths of an inch thick, which, with the five-eighths, is the usual thickness of the case wood used here for the lace trade. Random board lengths are absolutely required. As the boxes, especially for the lace and hosiery trades, vary greatly in size, but average large, the special lengths offered by your lumbermen are of no use whatever, as they entail more labor and room to store them separately than would be caused by crosscutting long lengths, say from 6 feet upward. The size generally required is five-eighths of an inch thick by 7 to 8 inches wide, and in length from 6 to 20 feet. The lumber should be planed or surfaced on one side only, and edges grooved and tongued. The lumber used here at present is chiefly North Carolina pine, but white pine and poplar will do equally as well, and a little sap or a few knots are not objected to, provided the timber is sound.

"As to price, case makers here, as elsewhere, in their anxiety to do the trade, are liable to undercut their competitors. Competitive merchants in their turn must follow suit, and we cannot afford to give more than about £8 10s. ($41.36) per standard of 720 feet lineal, three-fourths of an inch thick (or its equivalent of 2,640 feet superficial), c. i. f. Liverpool or Manchester, as on top of this price are dock dues of 5s. to 7s. 6d. ($1.22 to $1.82) per standard, and the carriage inland to Nottingham from Liverpool is £1 11s. 3d. ($7.36) and from Manchester £1 6s. 3d. ($6.38). Swedish and Russian timber is also bought at from £1 10s. to £2 ($7.30 to $9.73) less than £8 10s. ($41.36), and, coming into Hull or Grimsby, the inland carriage is only £1 2s. ($5.35). Thus, the advantage offered by the United States in admitting the cases free is minimized considerably by the actual difference in the cost of the timber used. Many goods other than lace and hosiery are shipped to the United States, such as tobacco, which requires only ungrooved but surfaced boards one fourth of an inch thick. If the American supply can be made to suit our requirements, there is no end to the market."

Another local firm—H. & M. Lewis, Canal Street—after altering lineal standard of 720 feet to superficial feet, made this statement, and it will be seen that these figures tally closely with those given by Mr. Cutts:

"American box shooks are now in good demand. They are required in lengths of, say, 10 to 16 feet, 6 inches and upward in width, and five-eighths of an inch in thickness, either planed on one side or unplaned, but must be of uniform thickness. The kind of wood is of no importance, provided it is all square edged and sound. To be a marketable article, it should be delivered in Liverpool at not more than $44 per standard of 2,640 superficial feet of board."

I am informed that considerable trade of this kind is established in London, where a charge exists of 2 per cent for cash against bills of lading. The usual time here is four months, or a discount charge of 2½ per cent cash within one month.—S. C. McFarland, Consul at Nottingham.

German Trade Methods in Chile.—Consul C. C. Greene writes from Antofagasta, March 9, 1902, in regard to German methods of securing trade in Peru, Chile, and Bolivia. He says:

Thirty years ago, the trade coming to the Pacific ports was monopolized by the British and a few American houses. The Germans were represented only by jobbers and shopkeepers in the coast towns. The Germans, appreciating the importance of this trade, made well-conceived plans to gain it. They carefully trained a number of able young men. When these were versed in commercial affairs and in the language of the people among whom they were to live, considerable shipments of goods were made to the British and American houses, and the young men found places as clerks and were given special charge of these consignments. They remained there till they acquired a complete knowledge of the coast trade; then they were provided with ample funds and stocks and opened German houses, with brilliant success. In many branches, they now have a monopoly, and the British and American houses no longer attempt competition.

The Germans not only established houses in the larger ports, but also agencies in the smaller ports and interior towns. Antofagasta is the port of entry and shipment for a large section of Bolivia. In former years, the trade of Bolivia was controlled by the wealthy British houses in Tacna, which had agencies in Bolivia. The American houses in Valparaiso also had a good deal of business in bark, etc. To-day, the Germans have it nearly all in their own hands. In the south of Chile, German banks not only do most of the German business, but a good share of the local trade.

* Advance Sheets No. 1192; Consular Reports No. 256.

The fine steamers of the Kosmos Company have extended their service to Central America and San Francisco. From this last port, they fetch barley, flour, etc., and even lumber of certain qualities, to ports as far south as Callao and Iquique.

We must follow German methods in foreign trade.

Consuls, in their own special sphere, have done much, but United States exporters must not rely too much on official representatives in extending commerce. The Germans have made progress, not through their consular service, but through private enterprise.

The occasional visits of commercial travelers can do some good, but can never develop important trade.

The Meat Trade at Nantes.*—Nantes has a population of about 200,000. It is an important port, and there is not only considerable meat consumed by the permanent residents of the city, but also by the vessels lying in the harbor.

All live stock and dressed meat brought into Nantes must first be taken to the city abattoir, or slaughterhouse, where it is inspected. The inspection staff consists of a director and two assistants, the former being an experienced veterinary surgeon. When any dispute arises as to the acceptance or rejection of meat, the matter is referred to the director, whose decision is final. Inspection is free.

The sale of mule and horse meat is confined to special shops, of which there are five in Nantes. Pork is also sold in separate shops. In addition to the animals slaughtered in the city, there is a large quantity of meat dressed in the country and brought here; in 1901, this amounted to the following:

Beef	pounds	2,110,671
Veal and mutton	pounds	465,557
Lamb	pounds	11,121
Lard	pounds	245,960
Dressed hogs	number	15,000

Upon this class of meat, the city imposes the following octroi taxes per 100 kilogrammes (220 pounds):

	Francs.
Beef	13 = $2.50
Sheep and calves	14 = 2.70
Pork	11 = 2.12

There is also an additional duty collected by the city, amounting to 2 francs (38.6 cents) per 100 kilogrammes for beef and 20 francs ($3.86) per 100 kilogrammes for pork.

Fresh meats retail at the following rates:

	Cents.
Beef	per pound 10 to 45
Pork	per pound 16 to 26
Veal	per pound 12 to 28
Mutton	per pound 12 to 25

Meat is delivered by boys employed in the various shops, who, in the morning, go about the city soliciting orders. The American meat wagon is unknown here. The shops are arranged very much as in the United States. Some of them have refrigerators, but many have no way of preserving the meat. On account of the sea air, meat does not spoil as quickly is in many parts of America; there are also very few flies to contaminate it.

Fowls are not on sale in the meat shops; they are sold in the market or are delivered at the door.

Of meat imported from other countries, there may be mentioned the large quantity of cured hams from England. These hams retail at about 28 cents per pound. Certainly, American hams could be sold to the consumer at a lower price.

The director of the abattoir, M. Louis Pingriè, is agitating the building of a cold-storage plant in connection with that establishment.—Joseph I. Brittain, Consul at Nantes.

Oregon Salmon in Germany.—During a recent conversation with a hotel proprietor of this city, I learned that Oregon salmon was sold in Germany to a very limited extent. This gentleman believes that a large business can be done in this particular fish, if special attention is given to transportation. He said he had eaten the fish in Magdeburg and Hanover and found it delicious. Inquiries as to price showed that Oregon salmon could be bought for 1.40 marks (35 cents), while German salmon costs at the present time 5 marks, or about $1.25 per pound. He also stated that the fish were frozen in Oregon and shipped in this frozen state to Europe. It is claimed that, if thawed in cold water and then cooked, the fish retains its flavor.

If the above is correct, there can be no doubt that this empire would make a very good market, as there is hardly any fish worth eating that can be had here for less than 40 cents per pound. The packers of Oregon salmon should look into this matter. A distributing house could be established in Hamburg or Bremen which would attend to the shipping of the fish to the inland German cities and towns.—J. F. Monaghan, Consul at Chemnitz.

American Efforts in Syria.—Consul G. B. Ravndal writes from Beirut, March 17, 1902:

In his last annual report on the commerce of Syria (published at Berlin in December, 1901), the German consul-general estimates the imports of Beirut at about $10,000,000 and the aggregate imports of the ports of Yafa, Haifa, Akka, Sidon, Tripoli, and Latakia at about $3,000,000. As to the distribution of this trade, he says:

"Of these imports, England must be credited with 40 per cent, Austria-Hungary with 15 per cent, Germany with 12 per cent, France with 10 per cent, and the other countries combined with about 23 per cent. Germany is third among the nations that sell to Syria and Palestine. France's exports to these parts have diminished during the last few years, to the advantage of Italy, Germany, Belgium, and the United States. Lately, the United States has been making efforts to get a firm foothold in Syria. To tell the truth, the Americans have succeeded in competing successfully with the European manufacturers in various lines. They have introduced their flour, cotton fabrics, farm machinery, iron and glassware, nails, beer, and canned goods."

* In reply to inquiries by the editor of a New York trade journal, who has received advance copy.

Opening for Automobiles in Syria and Palestine.—While it may sound strange, it is nevertheless true, that inquiries about automobiles are being made in Syria. Only one specimen, an inferior second-hand French machine, has been seen here; but it is thought that in Syria and Palestine, with their lack of railroads and street cars and with their rapidly developing carriage-road systems, automobiles would do well. A new road is now being built between Sidon and Beirut, and will soon replace the ancient bridle path. While this road will be level, others throughout this region are steep and make numerous sharp turns. Vehicles in use, therefore, must be strong and durable. Between Haifa and Nazareth, the most satisfactory carriages employed in the tourist traffic are powerful, two-seated surreys made in Buffalo, N. Y. In these parts, horses suffer greatly from the heat; this difficulty would not apply to a machine. In Beirut alone, 500 carriages are running, and hundreds more are in use in the Lebanon and in Palestine. The country is poor, and, except possibly for the accommodation of tourists, there would not at present be much demand for automobiles outside of Beirut.

The tourist traffic has more than doubled in Syria during the last ten years. At present, about 750 foreign tourists pass through Beirut annually, most of them proceeding to Baalbek and Damascus. Twice this number go through Palestine. Galilee is also growing in favor among tourists. The figures given do not include pilgrims, thousands of whom seek the holy places, nor the special excursions which lately have come into vogue. Recently the "Celtic" was here with 820 American tourists, while the "Augusta Victoria" brought some 400. Among local physicians, there is a growing sentiment in favor of the automobile. American manufacturers may address, on this subject, Dr. Harris Graham, Beirut, Syria.—G. B. Ravndal, Consul at Beirut.

Opening for Railway Material and Sugar Machinery.—The representatives of a syndicate of Dutch capitalists, Messrs. Von der Ben and F. W. Bolk, of Stork frères, Hengelo, Holland, came here recently to reorganize the large sugar plants in Rio and Sergipe. I called on the gentlemen to recommend the installation of American machinery for these plants. They will adopt it, if they receive favorable offers from American houses.

They want, among other things, electrical sugar machines of every kind, including cane crushers—not cutters—and dynamos and motors, variously described as of 220 kilowatts, 330 effective horse power, 220 and 440 volts—in short, everything requisite for the installation of large sugar refineries.

The same gentlemen are also interested in sugar refining in Java, and they are desirous of securing the sole agency for American rails for narrow-gage roads of from 75 to 100 centimeters (29.5 to 39.37 inches) in width, and for locomotives and other rolling stock to be used in the transportation of sugar over such roads.

American houses desiring to enter into negotiations for supplying the machinery required should address Stork frères, Hengelo, Holland.—Eugene Seeger, Consul-General at Rio de Janeiro.

American Agricultural Machinery in Switzerland.—Consular officers have often advised the sending of agents into foreign countries for the purpose of soliciting orders, and the value of this method is shown in the case of a large agricultural company now doing business in Switzerland. This company established an agency at Zurich about two years ago, and put in charge a practical American, who thoroughly understood the business. He brought with him samples of the implements which he considered adapted to the needs of the Swiss farmer. For the first six months, I do not think he had much success; in fact, I am inclined to believe that he did not book a single order. But by dint of hard work and practical demonstrations of what his agricultural implements could accomplish, he has gradually attracted the attention of the Swiss farmer, until now the business has increased to such proportions that several salesmen are kept on the road, and, as the utility of the implements is so well proved, there is no doubt that the sales will steadily increase from year to year.

Let our manufacturers and business men take this lesson to heart; what one agent has accomplished in the course of two years could never have been accomplished by means of catalogues.—Henry H. Morgan, Consul at Aarau.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECIPES.

The Chemist and Druggist says: "A subscriber at Cartagena (Colombia) sends us the following interesting information regarding Cartagena ipecacuanha. The collection of root, he says, takes place more or less all the year round on the immense area of land forming the basin of the Sinu and Atrato rivers. The digging takes place in a very rude and primitive manner, which accounts for the excess of dirt and foreign substances to be found among the drug. To this fact our correspondent attributes the low price (compared with Brazilian) that is paid in foreign markets. The gatherers, or raicilleros, as they are locally known, spend about a fortnight at intervals uprooting any plant similar in appearance to ipecac. The root is then conveyed to the villages, where it is sold to minor merchants, who dry it in the sun, half-free it from dirt and earth, and finally pack it for export in hemp bags. In this condition it reaches Europe, principally London and Hamburg. It is estimated that an average of about 100 hundredweight per month passes through the port of Cartagena, and some 50 hundredweight through Savanilla. The price paid by merchants in the villages of Sinu and Atrato is $15 (Colombian currency) per pound, equivalent to 3s. By the time Cartagena and Barranquilla are reached the value has increased to about 4s. 6d. to 5s. per pound. The laborers who first gather the root earn about £15 in the two weeks, as during that time they can collect at least 100 pounds of the drug."

To Clarify Liqueurs.—For the clarification of turbid liqueurs, burnt powdered alum is frequently employed. Make a trial with 2 liters of the dim liqueur, to which 15 of burnt powdered alum is added; shake well and let stand until the liquid is clear. Then decant and filter the last portion. If the trial is successful, the whole stock may be clarified in this manner.—Neueste Erfindungen und Erfahrungen.

Packing for Stuffing Boxes.—

Tallow	10 kilos
Barrel soap, non-filled	30 kilos
Cylinder oil	10 kilos
Talcum venetian, finely powdered	20 kilos
Graphite, finely washed	6 kilos
Powdered asbestos	6 kilos

Melt the tallow and barrel soap together, add the other materials in rotation, mix intimately in a mixing machine, and fill in 2 kilo cans.

Tree Wax.—I. Liquid tree wax. Melt rosin 500 grammes and mutton tallow 45 grammes, then add 250 grammes of denatured spirit, previously warmed in the water bath.

II. Cold liquid tree wax. Melt pine resin (galipot) 500 grammes, together with yellow wax 200 grammes, technical vaseline 150 grammes, ordinary potash soap 100 grammes, liquid tree wax 100 grammes, and common turpentine 50 grammes. A plastic, readily kneadable mass will result.

III. Tree wax in bars. Melt rosin 300 grammes, together with ceresine (yellow) 300 grammes, and common turpentine 150 grammes.

On the other hand, heat 100 grammes of rapeseed oil with 50 grammes of powdered turmeric in the water bath, strain, squeeze out, and unite the molten mass with the hot oil; allow to cool and roll out into bars.

A very good tree wax, in bars, which is also excellent as a wig wax, is obtained by the following recipe:

Pine resin	50 parts
Yellow wax	18 parts
Common turpentine	25 parts
Linseed oil	15 parts
Lard	3 parts
Turmeric	1 part

Melt over a moderate fire, allow to settle, strain, and, after the half-cooled mass has been thoroughly kneaded, roll into bars.—Deutsche Drogisten Zeitung.

Preservative for Stuffed Animals.—For the exterior preservation use:

Arsenic	0.7 gramme
Alum	15.0 grammes
Water	100.0 grammes

For sprinkling the inside skin, as well as filling bones, the following is employed:

Camphor	100 grammes
Insect powder	100 grammes
Black pepper	50 grammes
Flowers of sulphur	200 grammes
Alum	150 grammes
Calc. soda	150 grammes
Tobacco powder	150 grammes

—Deutsche Drogisten Zeitung.

Rust Spot Remover.—This is produced as follows: Dissolve potassium bioxalate 200 in distilled water, 8,800, add glycerin, 1,000, and filter. Moisten the rust or ink spots with this solution; let the linen, etc., lie for three hours, rubbing the moistened spots frequently, and then wash out well with water.

Heel Polish for Shoemakers.—Melt together Japanese wax, 1,000; carnauba wax, 1,000; paraffine, 1,000; and mix with turpentine oil, 5,000, as well as a trituration of lamp black, 100; wine black, 200; turpentine oil, 700.—Neueste Erfindungen und Erfahrungen.

Lemonade Preparations for the Sick.—For the production of lemonade preparations for the sick, the Pharmaceutische Rundschau gives the following recipes:

1. Strawberry Lemonade: Citric acid, 6; water, 100; sugar, 450; strawberry sirup, 600; cherry sirup, 300; claret, 450; aromatic tincture, 15 drops.

2. Lemonade Powder: Sodium bicarbonate, 65; tartaric acid, 60; sugar, 125; lemon oil, 12 drops.

3. Lemonade Juice: Sugar sirup, 200; tartaric acid, 15; distilled water, 100; lemon oil, 3; tincture of vanilla, 6 drops.

4. Lemonade Lozenges: Tartaric acid, 10; sugar, 30; gum arabic, 2; powdered starch, 0.5; lemon oil, 6 drops; tincture of vanilla, 25 drops, and sufficient diluted spirit of wine, so that 30 lozenges can be made with it.

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